A GUIDE TO MENTAL TESTING

RAYMOND B. CATTELL

THE TWO MAIN PURPOSES of this book are : *to provide* instructions, test materials and norms to aid the psychometrist in assessing the principal aspects of personality (including abilities) so far made accessible to exact examination ; and *to provide a* guide to most available *tests of substantial* value, with comments on their origin, validity and source of publication. Both English and American tests are included. This new edition contains much additional material s a result of progress in esearch and the publication of new tests.

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THE DESCRIPTION AND MEASUREMENT
OF PERSONALITY

A GUIDE TO MENTAL TESTING

For Psychological Clinics, Schools, and
Industrial Psychologists

By

RAYMOND B. CATTELL, M.A., D.Sc.
Research Professor of Psychology, University of Illinois
Formerly Director of School Psychological Service and Clinic, City of Leicester

WITH A FOREWORD BY
WILLIAM MOODIE, M.D., F.R.C.P., D.P.M.
Medical Director, London Child Guidance Clinic

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DEDICATED TO MY CO-WORKERS IN THE
PSYCHOLOGICAL CLINIC AND
THE EXPERIMENTAL SCHOOL.

CECILIA BAKER. RICHARD DEWHIRST.
JESSEY LOWE. WINIFRED MILLER.
DIANA MILLIS. MARJORIE RAILTON.
MARGARET WALTON. JAMES WILLSON.

তাং

FOREWORD

For some time there has been a lull in the progress of mental testing as a practical procedure. After the first wave of enthusiasm in the so-called Intelligence Tests, and their indiscriminate and often unintelligent application, this was bound to happen. It became evident that the results of these tests were influenced by factors other than intelligence, which seemed to elude measurement even if they were taken into account at all.

The psychotherapist, faced with problems of behaviour dependent on forces much more instinctive than intellectual, found the estimation of mental endowment alone of only limited value, especially since variations in mental capacity were always complicated by disturbances of the personality.

This was also the lot of the educational psychologist. Attainments often showed a marked discrepancy with test rating. Something obviously remained unexplained.

So the problem was thrown back and forth from one to the other, without any definite solution being arrived at.

In this book we have a much-needed and remarkably successful attempt to end this state of affairs. Looking on his subject from a wide angle, Dr. Cattell has sifted all those methods which aim at estimating, so far as can be, the various activities of the mind, using the term in a broad sense. He has wisely selected for detailed description only those whose value has been proved, and which are suitable for practical application. He has been critical and selective, and necessarily so, and he has substantiated his work with ample references.

Here, for the first time, is collected under one cover, reliable information on all aspects of the subject. This book fills a long-felt want, and all practical psychologists, whether in educational, child guidance, or medical fields, will welcome it.

WILLIAM MOODIE, M.D., F.R.C.P., D.P.M.,
Medical Director, London Child Guidance Clinic.

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INTRODUCTION

For some unaccountable reason the expression 'Mental Testing' has been understood by many teachers and even a few psychologists as if it were written 'Intelligence Testing.' Text-books and articles dealing only with intelligence tests, or at the most with cognitive material, still appear bearing the title "Mental Tests." Obviously 'mental' should refer to the mind in all its aspects, intellectual and emotional, and that is the sense it bears in the title of this book, which deals with tests and diagnostic methods in regard to intelligence, attainment, special aptitudes, interests, emotional structure, temperament, and character.

My aim has been to provide (1) A handbook which shall contain between its covers sufficient instructions, test materials and norms to aid the psychometrist in assessing the principal aspects of personality so far made accessible to exact examination. Without a practical handbook of this kind the psychologist is reduced to the time-consuming inconvenience of having to consult many different reference books and of carrying with him portfolios of obstinately errant test material.

Naturally the exactness and reliability vary considerably between such fields as intelligence testing, where research has long provided a sound theoretical basis, and the latest essays at character analysis which tread closely on the heels of pioneer research and can only be tentatively interpreted. With this explanation perhaps no apology is necessary for presenting relatively untried tests in the character-temperament section. They have promise in a region where most tests are of low validity and their publication may at least stimulate further research.

(2) A guide to most other available tests of any value (and from which the above are a selection), with brief

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comments on their origin, validity, and source of publication. In general, only one or two tests are given in each field. Where American and English Tests are of equal goodness, the latter are usually given, since American standardisations are in some fields inapt to testing purposes in this country; but always the test based on sounder research is given first consideration. Tests of doubtful value are generally given no more space than suffices to print their titles. Even so, a complete catalogue of every test described in journals or placed on the market has not been attempted. Such a complete list already exists in Dr. G. Hildreth's *A Bibliography of Mental Tests and Rating Scales* (Psychological Corporation, N.Y., 1933), where over four thousand titles are recorded. A slightly less exhaustive but even more valuable survey and commentary on available tests—valuable particularly because it is constantly kept up to date—is O. K. Buros' *Mental Measurements Yearbook*.

The psychology of measurement is still greatly beset by growing pains. Only a thoroughly trained professional psychologist can hope to get a right perspective on the value and use of recent developments. But, since many psychometrists with lesser training have to use tests, some explanation or summary of basic principles cannot be omitted in a book of this kind. Although it is intended primarily as a handy tool for the busy practical psychologist and as a guide for the inquirer after new tests, it prefaces each set of tests with a condensed account of the present position of research in the field concerned. Since this must be very brief, it is necessarily more dogmatic in tone than one would ideally like it to be. There is also a section on the interpretation and synthesis of test findings. These statements of the general background should be of considerable help to teachers and psychometrists, whilst even the fully qualified psychologist will sometimes find it convenient to have at hand ready references to the research sources of his accepted techniques.

Two eccentricities require explanation. I have omitted detailed description of the Binet Scale and its revisions because, in spite of its continued use by medical officers and others, I find no scientific evidence for its being as valid as most of the tests devised since Spearman's principles were discovered. Besides which, it has too few pass or fail items, does not include tests for higher mental ages, contains tests of low 'g' validity, and is overloaded with life experience and scholastic skill. It is presented, therefore, only as one test among many of equal worth. Secondly, I have used everywhere 'Consistency Coefficient' as well as 'Reliability Coefficient.' To the layman, at least, 'reliability' conveys more than that the test correlates highly with itself, and I am inclined to think that even to many psychologists it is subtly misleading. Consistency, on the other hand, expresses exactly what the coefficient measures. Probably the best system would be to apply the term Consistency Coefficient to self-correlations obtained by the 'split-half' method or from two testings in quick succession, and to reserve the term Reliability Coefficient for correlations obtained from testings separated by long intervals of time. In that case the Consistency Coefficient would be the measure of the self-consistency of the test, whilst the Reliability Coefficient would indicate in addition the degree of variability (with time) of the quality assessed, i.e. its "functional fluctuation."

All being well, this handbook will be revised at intervals in response to the progress of research and the publication of new tests. I shall be greatly indebted to anyone bringing to my notice tests which he considers ought to be included or supplying new and more extensive norms for tests already described. Much arduous work has in the past been unnecessarily repeated, and research inquiries duplicated through the lack of some central co-ordinating body, but with the recent establishment of the British Committee on Human Mental Measurements, to which the writer has the privilege to belong, this confusion should give way to a progressive organisation of test material, norms, and standards which it is hoped will be reflected in future editions of this or similar books.

I am greatly indebted to Professor Burt for permission to reproduce certain items from his classical *Mental and Scholastic Tests*, to which some sections of the present book are an introduction.

RAYMOND B. CATTELL.

UNIVERSITY OF ILLINOIS,
1946.

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CHAPTER I

THE MEASUREMENT OF INTELLIGENCE

1. The Nature of Psychological Measurement in General

MENTAL testing is concerned with defining the individual personality at a given moment, i.e. with diagnosis. The art of guidance, of therapy, of prediction and control of behaviour in various applied fields, goes far beyond this and requires a systematic knowledge of developmental psychology through which the significance of the given measurements can be appreciated. A layman holding a mental-testing handbook is not a psychologist. It is necessary to stress this fact, because the present work, in order to retain a reasonable size, is compelled to confine itself rather strictly to the problems of description and measurement, assuming at every point that the reader is supplementing the bare statements of measurement with a wealth of implication from his psychological training.

The immediate task of description and measurement is presided over by two domestic gods—the reliability coefficient and the validity coefficient. Every measuring device must demonstrate that it is consistent with itself when applied on subsequent occasions and that, in addition, it measures the aspect of personality it is supposed to measure. These seemingly simple requirements are, however, much confused in current practice and it behoves us to define them more precisely.

Before we can validate a test we have to define the trait which it is designed to measure. Accurate qualitative description therefore has to precede measurement. In other words, psychology has to explore the characters of the unitary traits of man before mental testing can begin. Some traits are absolutely unique to individuals—like a six-fingered hand—and cannot be expressed in any scale common to all human beings. Mental testing is at present concerned with common traits; those of which every human being possesses a certain amount. Common traits are established by correlation studies correlating restricted manifestations of behaviour which we may call 'trait elements.' When a group of trait elements vary together we say that they constitute a unitary trait.

Unitary traits are of two kinds—surface traits or syndromes and source traits. The former are revealed by a cluster of positively intercorrelating elements, in which each correlates with every other member of the group. Most of the syndromes of psychiatry are correlation clusters, as also are most of the old 'types.' An exhaustive review of known correlation clusters has been published elsewhere.[1]

Source traits, on the other hand, may be regarded as the basic independent influences behind the clusters. They are discoverable by factor analysis, which reveals the distinct factors or vectors required to account for the observed correlations. Not all factors are psychologically meaningful source traits. A special technique is required in research to ensure that the mathematical analysis shall reveal the root psychological entities.[2]

A correlation cluster seems to be sometimes the result of a single factor, as, for example, in the Dominance syndrome or the Intelligence-General Talent Cluster; but more frequently it is due to the cumulative effects of two or more overlapping factors. The 'extraversion' cluster, for example, seems to be the consequence of at least three factor endowments, in cyclothymia, in dominance and in surgency. The source trait is thus interpretative—it penetrates below the surface of behaviour to the underlying unitary influence—whereas the surface trait is almost purely descriptive, being simply a statement that a certain group of behaviour manifestations go together, for reasons unknown, or at least neglected.

---

[1] "The Principal Trait Clusters for Describing Personality," R. B. Cattell, *Psychological Bulletin*, xlii, 161–192, 1945.

[2] This technique and all the theoretical background of the present section is discussed at length in *The Description and Measurement of Personality*, R. B. Cattell, World Book Co., Yonkers-on-Hudson, New York, 1946.

Surface traits, as research shows and the theory of structure might lead us to expect, are decidedly more numerous than source traits. For this and other reasons, applied psychology is likely to deal more with source traits than surface traits. Of course, the two systems of description and measurement are not mutually exclusive, but are actually alternative means of dealing with and resolving exactly the same set of observations. Unfortunately, a good deal of applied psychology up to the present has dealt with neither surface traits nor source traits, but with arbitrary, 'logical' trait definitions. These 'traits' are taken from the dictionary or manufactured in the mind of the psychometrist—e.g. clerical aptitude, social intelligence, 'paragraph comprehension'—and have generally never been demonstrated to correspond to any natural entity. To attempt to validate a test against such a composite is strictly meaningless. It is like asking for a compass that will simultaneously point north, south, east, and west.

If we deal with the measurement and prediction of behaviour performances in terms of source traits, i.e. factors, the procedure reduces to that expressed by the following basic formula:

$$P_{jk} = a_kF_{1j} + b_kF_{2j} \quad . \quad . \quad . + m_kF_{nj}$$

where P_{jk} is the estimated performance of the individual j in the situation k; F_{1j} is the endowment of the individual j in the source trait F_1 (and similarly for the source traits F_1, F_2, etc.); and a_k is the loading of the factor F_1 in the performance k, i.e. its rôle and importance in respect to k. For the fuller understanding of factor analysis and factorial representation the reader is referred to the several excellent expositions now available.[1] The formula at least suffices to remind one that the prediction of any performance—in school, occupation, therapeutic situation, etc.—normally requires measurements of several source traits, if the range of individual variation in the performance in question is to be fully accounted for.

---

[1] Burt, C. L., *The Factors of the Mind* (London: University of London Press, 1940); Guilford, J. P., *Psychometric Methods* (New York: McGraw-Hill Book Company, Inc., 1936); Holzinger, K. J., and Harman, H. H., *Factor Analysis* (Chicago: University of Chicago Press, 1940); Thomson, H. G., *The Factorial Analysis of Human Ability* (London: University of London Press, 1939), Revised Edition, 1946; Thurstone, L. L., *The Vectors of the Mind* (Chicago: University of Chicago Press, 1935), Revised Edition, 1944.

2. Validity, Reliability, Consistency

The validity of a test aiming to measure a source trait is its factor loading in the factor concerned. With independent, orthogonal factors this is the correlation of the test with the pure factor as criterion.

The validity of a test aiming to measure a surface trait is the correlation of the test with a weighted or unweighted pool of the trait elements in the cluster. The well-known process of ' item analysis ' is, at its best, the validation of test items in terms of a surface trait. Unfortunately, in many instances of item analysis no attempt has first been made to ascertain that the test as a whole constitutes a single cluster, and in many important instances later research has shown the criterion to be a composite of two or more distinct clusters and any number of factors.

One may seek to establish the reliability of a test either by correlating odd with even items at a single administration or by correlating one administration with a later one. There are important differences between these results which justify calling them by different names, and the writer would suggest ' odd-even consistency ' for the first and ' quotidian reliability ' for the second. If the odd-even consistency coefficient is low, the test is bad; but if the quotidian reliability is low, it may show only that the ability which the test measures does indeed fluctuate from day to day. The latter tendency, intrinsic to certain traits, e.g. in a marked degree to surgency and to neuroticism, has been called ' function fluctuation,' or ' quotidian variability.' The relation between the odd-even ('split-half') consistency coefficient and the reliability (test-retest) coefficient permits one to calculate how much of the variance in measurement is due to each source—experimental error of measurement and function fluctuation. This analysis of source trait measurements with respect to validity, experimental error, and function fluctuation is illustrated in more detail below with respect to the measurement of intelligence. The problem of validation itself is discussed in more detail, with respect to ' internal ' and ' external ' validation, in Chapter V.

Ideally we should record validity, consistency, and reliability coefficients systematically for every test examined and described in this compendium. Actually we have been compelled to handle the evaluation more flexibly and inexactly. The recording of such coefficients, where they have been published, would at present merely operate to create a false impression of precision and of the relative merits of tests. For, as statisticians well know, the consistency coefficient can always be made to reach a ' satisfactory ' level by taking a population sample with sufficiently high scatter. Until all published coefficients have been systematically corrected to some standard scatter, preferably that of the total population, it will be pointless and misleading to set them out here. The same applies *a fortiori* to validities, and with the added complication that very few tests have yet been validated against estimated pure factors.

3. The Nature of Intelligence

The problem of measuring intelligence may well be taken as a paradigm for the treatment of most other source traits. *Historically* it can scarcely constitute a model, for the gropings and errors which occurred in attaining to clarity need not be repeated with other factors.

So long as controversy existed as to what was meant by intelligence no test could truly be validated, and the design of tests perforce remained a matter of personal taste. However, the researches which began with Spearman and were refined by Thurstone, as well as the more naturalistic studies of Terman with the Binet, demonstrate that abilities in general may be conceived as (1) a general ability entering into almost all performances, but far more into complex relation eduction than other performances; (2) certain group factors each covering an area such as verbal, number, spatial, musical, etc., performance; and (3) certain abilities which are absolutely specific to one performance.

The analyses of Thurstone differ from those of Spearman and Holzinger in giving less weight to the general ability. For Thurstone first resolves the performance wholly into the equivalent of group factors, namely into 'Primary Abilities,' and then takes the general factor as whatever the primary abilities have in common.

The techniques of measuring primary abilities *per se* are discussed in the next chapter, which is concerned with group and specific abilities. Here we shall discuss the measurement of the general factor, which corresponds—if anything corresponds—to what the general public alludes to by the term 'intelligence.'

If we agree that intelligence is the most general ability, i.e. the 'g' factor, the choice of 'intelligence tests' is no longer on an arbitrary basis. A good sub-test in an intelligence test battery is one that correlates very highly with 'g' and has only a small specific 's.' The same technique enables one to decide to what extent 'g' is important in various school subjects and adult occupations, i.e. to predict from tests the fields in which a person may be successful and to what extent.

Measurements of 'g' show that it increases rapidly in early years, then more slowly towards 14, and remains constant after about 15 years of age. The exact age of cessation of growth is still a matter for inquiry, but there are indications[1] that in the normal child intelligence ceases to grow after 16 years, in the subnormal after 14 years, and in the supernormal after 18 years.

'g' is primarily expressed in terms of mental age. The child who scores as many points on a given test as, say, the average child of 11, is said to have a mental age of 11. His intelligence quotient (I.Q.) is obtained by dividing his mental age by his chronological age. To avoid fractions, the quotient is multiplied by 100. Thus a child with a mental age of 8 and an actual age of 10 would possess an I.Q. of 80:

---

[1] "Occupational Norms of Intelligence and the Standardisation of an Adult Intelligence Test," by R. B. Cattell, *Brit. J. Psychol.*, xxv, 1, 1934.

$$\text{I.Q.} = \frac{8 \times 100}{10} = 80$$

This intelligence quotient remains remarkably constant for any given individual both during childhood and in adult life.[1] Differences of mental exercise and even of nutrition seem to affect it but little, though certain diseases may result in a reduction of I.Q.[2]

4. Technique of Measurement

Although one aims at measuring inborn capacity, there is no reason why it should not be accurately measured inferentially through the medium of some acquired ability, e.g. reading and verbal ability, provided all the persons to be measured have had equal training, i.e. have been equally exposed to opportunities for acquiring verbal skill. Indeed, experiment has shown that verbal tests may be decidedly more ' saturated ' with ' g ' than most non-verbal and performance tests. Stephenson[3] has shown, however, that there is probably a verbal factor over and above ' g ' running pretty evenly through most verbal sub-tests, and that non-verbal tests are free from this. Nevertheless, having regard to the high saturation of the former with ' g ' and to the fewness of satisfactory non-verbal sub-tests, there is little inaccuracy in using a verbal test whenever a normal level of verbal education can be taken for granted, i.e. whenever one can be certain that the vocabulary demanded by the test is well within the vocabulary of even the most backward of the subjects.

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[1] " The Constancy of ' g,' " by C. S. Slocombe, *Brit. J. Psychol.*, xxvi, 17, 1926.

[2] *Physique and Intellect*, by Paterson, 1930.

[3] *J. Educ. Psychol.*, March 1931.

In any other circumstances, as when a child has missed much schooling, or in testing foreigners not fully skilled in the language, or in all testing of young children below the age of 8, or especially with deaf and dumb children, a non-verbal or performance test is indispensable.

Tests may be classified in various ways, and the division into verbal and performance tests or into group and individual tests is by no means exhaustive. There are verbal tests which require no reading or writing; there are verbal tests requiring only reading ability (no speaking or writing), and there are non-verbal tests which do not differ in any significant way from performance tests, except that they are done on paper and require movements of a pencil instead of movements of a wooden model. Again, even within the class of non-verbal paper tests, there is a very significant difference between 'pictorial' tests on the one hand and on the other 'perceptual' tests which deal only with lines and figures having no meaning or associations other than those directly given to perception. The latter could be used in inter-racial comparisons, even of civilised and uncivilised peoples, whereas the former, though suitable for peoples speaking different languages, could not be used where the pictures would be differently interpreted.

Everything considered, the most useful classification for the practitioner is into paper tests on the one hand and performance tests on the other. For the latter are almost exclusively individual tests, and their bulkiness frequently precludes their use outside the clinic or laboratory; whilst the former, whether verbal or non-verbal, can be used either as group tests or individual tests and are conveniently applied almost anywhere.

5. Test Material

(A) PAPER TESTS—VERBAL AND NON-VERBAL PICTORIAL

There are at least four criteria by which a good intelligence test can be judged: (1) It should contain only subtests highly saturated with 'g.' These are such as Synonyms,[1] Classification, Instructions, Completion, Opposites, Analogies, Inferences, etc., and their various modifications, together with others yet to be devised and assayed. Some tests, e.g. Substitution, are good at low mental ages but not so g-saturated higher up. (2) It should be finely graded, i.e. have a large number (100–200) pass or fail items, which should be arranged in order of increasing difficulty. (3) It should be nicely adjusted in difficulty to the age of the subjects, and should not attempt to extend over too wide a range. (4) It should be adequately standardised on a truly representative sample of the population. That it should be intrinsically interesting goes without saying, though it is part of the psychologist's technique, in administration, to make every test entertaining.

Intelligence tests, like most Attainment tests, may be designed to permit either of 'selective' or 'inventive' answers. In the latter, the subject supplies the answer himself, whereas in the former he chooses the answer from a number of given alternatives. Although the selective system allows a certain number of correct responses to be obtained by sheer chance, it renders the test more objectively evaluated and eliminates the factor of mere ability to recall items stored in memory, a factor which is certainly quite distinct from intelligence. Most researches indicate that the selective form is more effective for the majority of uses,[2] and the principle is now followed in all good tests.

Granted that the strongest possible motives—competition, desire to please an adult, self-regard, curiosity—have been enlisted, and a sense of pleasurable anticipation aroused, the administration of most tests is a relatively straightforward proceeding. Nevertheless, the experience of most psychologists shows that many teachers have to be warned to resist the teacher's impulse to give help or instruction, and instead to follow the directions with unmitigated exactness. Not only is it necessary to get children uniformly interested, but also to give confidence to those who are nervous. In general, when one knows which is the duller and which the brighter section of the class, the former should be put at the front in order that one may watch lest they go widely astray, give them encouragement, and prevent copying—all of which errors of testing are more common in the duller sections.

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[1] "Three Points of Interest to Mental Test Constructors," by C. S. Slocombe, *Brit. J. Psychol.*, xxviii, 19.

[2] "An Enquiry into the Relative Values of the Inventive and Selective Forms of Group Tests of Mental Capacity," by J. G. Cannon, *Austral. J. Psychol.*, iv, 25.

Most tests have a time limit, which also should be exactly observed. The imposition of a time limit is in theory sound, since, granted the intention to work quickly, intelligent individuals are quicker [1] and consequently are penalised in a test without time limits by having to dally while the duller ones catch up. Nevertheless, temperamental slowness or quickness to some extent breaks through the intention to work quickly, and in any case nervous individuals may be flustered by the awareness that they will have to work at undue speed. Consequently the time limit has been adjusted in the author's tests to permit the average child just sufficient time to complete the test easily. With adults an exacting time limit is open to still greater objections, for experiments have shown that the performance of adults on speeded tests declines from about the age of 25, whereas 'power,' i.e. the ability granted adequate time, does not.[2] The general ability with adults becomes invested more in particular skills and fields of ability. The individual differences due to the general ability become less important and those due to the group factors become more important. But even the general ability loses some of its fluidity. In fact, there are quite a number of differences between the manifestations of general ability in children and in adults, which led the writer to propose the theory of two forms of 'g'—'fluid' and 'crystallised.'[3] It is important to be aware of these in making any comparisons of children's and adults' mental measurements and in making predictions from them.

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[1] See *Quickness and Intelligence*, by E. Bernstein, *Brit. J. Psychol. Monog. Suppl.* No. 7. Also Vernon, P. E., "Intelligence Test Sophistication," *Brit. J. Educ. Psychol.*, 1938, viii, 237–44.

[2] See Lorge, I. "The Influence of the Test upon Mental Decline as a Function of Age," *J. Educ. Psychol.*, 1936, xxxii, 100–10.

[3] Cattell, R. B., "The Measurement of Adult Intelligence," *Psychol. Bulletin*, 1943, xl, 153–93.

In many instances one wishes to retest a child's intelligence after the lapse of some months or years. When more than a year elapses it is quite safe to use the same test, for the test items are almost invariably forgotten, and in any case the child's growing intelligence encounters the critical questions within a new region of the scale.

But for purposes of more immediate retesting, the best-known tests are always prepared in an A and a B Form of equal difficulty and similar construction—the B Form being for retesting shortly after the A Form has been used. The layman is frequently suspicious as to the effects of practice in intelligence testing. Since practice does not increase intelligence itself, the better the intelligence test—i.e. the more it is saturated with ' g '—the less it is susceptible to practice effects. Experiment shows that in repeated testings the score goes up very slightly between the first and second testings, but that thereafter the increase is quite negligible. This first increase through practice, as also, to some extent, that resulting from coaching, is nothing more than the settling down to that type of examination situation, and is only appreciable in the lower intelligence levels, or among very young children and with adults who have never been in an examination situation. In these cases—or still more where these cases are in a mixed group with practised individuals—it is wise to give a short 'practice' or 'buffer' test (the results of which are thrown away) before the test proper, when any accurate results are required.[1] For this reason the scores (but, of course, not the I.Q.) on the B Forms which are intended to be given last, are slightly higher than the equivalent scores on the A Forms, at least over the lower ranges of intelligence.

To see the meaning of an intelligence test score in full perspective we may represent it by the following formula [1]

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[1] See e.g. C. S. Slocombe, "The Influence of Practice on Mental Tests," *Forum of Educ.*, xxvi, 3.

$$\text{Performance} = G + dG + c + t + f + fv + e + R$$

in which G is the innate general ability; dG the environmentally produced change in general ability; c the cultural gain through the test being in informations or skills advantageous to the individual in question; t the effect of training specifically in intelligence test situations; f the 'function fluctuation' through psychological change or fatigue, etc.; fv the function fluctuation through changes in will and interest; e the experimental error in measurement from all other causes, extrinsic to the subject; and R the influence of specific abilities unavoidably included with the general ability measure.

(i) *Test Material Available* (*Detailed*)

At present some two dozen group and individual tests in Britain and America satisfy the above demands. Particulars of the age-ranges for which they are suitable and the time required are set out below. Since details of administration and norms are given in the respective handbooks issued with the tests, no further instructions in regard to the use of these tests need be given here (except in the case of the author's own tests, where new norms are set out more recent than those available in the handbook). The Binet-Simon scale or any of its modifications is not included among them, for reasons given in the Foreword. Its component test items are frequently more tests of scholastic attainment and life experience than of 'g,' [2] and the pass or fail items are far too few. The personal relationship that arises between tester and tested in the course of the testing, and which is sometimes claimed to give greater reliability to this type of individual test, is just as likely to introduce errors because of shyness and other temperamental effects in the child[1] and because the examiner is likely to be affected in doubtful cases by the appearance and bearing of the child.[2] It is certainly true that the examiner gains evidence of temperament and character traits in administering the Binet intelligence scale which he would not gain with paper tests, but when definite temperament tests are available it is a mistake to vitiate the intelligence test by roughly blending the two. The retention of the Binet tests in a good deal of clinical work to-day is alike a great tribute to the early genius of Binet and to the conservatism, rather than the scientific conscience, of the present generation of clinical psychologists.

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[1] Cattell, R. B., "A Culture-Free Intelligence Test, I and II," *J. Educ. Psychol.*, 1940, xxxi, 161–80, and 1941, xxxii, 81–100.

[2] See e.g. "Intelligence Tests for Children of 4 to 8 Years," R. B. Cattell and H. Bristol, *Brit. J. Educ. Psychol.*, iii, 1933.

The following is a list of some good available tests, in alphabetical order. When inspecting the descriptions of tests it is necessary to remember that, generally speaking, an intelligence test should not have less than 30 minutes' duration (more with young children). Teachers are often inclined to use shorter and shorter tests, whilst still hoping to use the results as a basis for important decisions—sometimes affecting the candidate's whole career. Fifty minutes is not too much when such decisions are in question. The tests have been arranged according to age levels, i.e. according to the *mental ages* for which they are suitable, and are provided with brief comments on their structure. Certain tests, notably the Northumberland, the National Institute, and the Cattell Tests, provide a complete series of uniform tests, one for each age-range section. With the exception of the Otis Test, they are all English, since the wording and standardisation of American tests are often unsuitable for English children.

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[1] See also the evidence in Chapter VII, p. 302.

[2] Too strong a motivation in intelligence testing—as in most cognitive performance—may be disadvantageous.

A group test would seem to produce quite adequate attention and interest. Over a wide range of motivation strength there is practically no variation of score on intelligence tests. Maller and Zubin ("The Effect of Motivation upon Intelligence Test Scores," *J. Genet. Psychol.*, xli, 136) found that very strong motive led to (i) no increase of score, (ii) increase in number of items attempted, balanced by (iii) increase in number of errors. See also A. Wild, "The Effect of Conation upon Cognition," *Brit. J. Psychol.*

Infancy: 0–4-*year Range*

Gesell's Norms of Development from birth to the sixth year. Available in *The Mental Growth of the Pre-school Child* (Macmillan). No unusual apparatus needed. These test situations are by no means always tests of intelligence, but are probably fairly saturated with ' g ' during the first and second year, especially those items in the "Adaptive Behaviour" section (chap. x). (No investigations on ' g ' value have been made.) They enable one to fix mental age to within about two months. Carefully selected and standardised, but the norms in the upper ages are a little low for English children.

Brief ' Mental Capacity ' Scale from Gesell (mainly ' Adaptive Behaviour ' Items) for 0–4 Year Range

4 months	85 to 100%.	Can lift head when lying on back. Resist pressure to move head.
	65 to 85%.	Follow slowly-moving plate or bright light with eyes.
	20 to 50%.	Move arms in an attempt to shift piece of paper (letter size) placed over face when prone on back.
6 months	85 to 100%.	Pick up spoon from table.
	65 to 85%.	Sit up with slight support.
	,, ,, ,,	Express recognition of strangers as being different from familiar faces.
	20 to 50%.	Look round for fallen spoon.
	0 to 20%.	Sit up alone.
9 months	85 to 100%.	Sit up alone.
	65 to 84%.	React to mirror images (of self) shown. Some response indicating interest or recognition counts as a pass.
	,, ,, ,,	Clasp and pull down ring dangled on string just above head.
	,, ,, ,,	Can say ' Mama ' and ' Dada ' and one other word.
	20 to 50%.	Lift inverted cup to recover cube after seeing cube placed under cup.
12 months	65 to 75%.	Place cube in cup when told (without assistance by gesture)
	50 to 65%.	Climb (crawl) up stairs.
	20 to 50%.	Walk alone.
	,, ,, ,,	Can pile *three* blocks (cubes) on top of each other to make a stable pile, after once seeing it done.
18 months	65 to 85%.	Make attempt to turn knob when wanting door open.
	50 to 65%.	Make single vertical stroke (distinct from scribble) after seeing one made as a model.
	20 to 50%.	Put cube in plate or in cup according to instructions (i.e. discriminate between plate and cup).
	,, ,, ,,	Point to two parts of body (out of eye, nose, mouth).
	,, ,, ,,	Pile *four* blocks in a stable pillar (see above).

2 years	65 to 85%.	Pile *four* blocks in a stable pillar (see above).
	,, ,, ,,	Make single vertical stroke, with pencil, in imitation (see above).
	50 to 65%.	Obey propositions: Put the ball on the box. Put the ball in the box. Put the ball behind the box. Put the ball in front of the box (or chair). Put the ball under the chair. (getting *three* correct.)
	20 to 50%.	Make tolerable drawing of a circle after seeing one drawn.
	,, ,, ,,	Build 'bridge' with three bricks after seeing one made.
	,, ,,	Can name *three* objects in a picture (Dutch Home Scene, ("Tell me what you can see").
3 years	65 to 85%.	Use pronouns, plurals, and past tense in speech.
	,, ,, ,,	Presented with several cubes and cup. "Put just *one* block into the cup." Respond correctly.
	50 to 65%.	"Put *two* blocks in cup" (as above and after doing one successfully). Respond correctly.
	20 to 50%.	Copy a cross just recognisably from a model + presented (but not drawn in their presence).
	,, ,, ,,	Can carry out three commissions without asking further. "Here's a key; I want you to put it on that chair over there; then I want you to shut that door, and then bring me the box which you see over there." (Pointing in turn to these objects.) Repeat, stressing: *First* put the key on the chair; *then*, etc.
4 years	65 to 85%.	Successfully respond to instructions to put only two cubes in cup. (See 3-year test above.)
	,, ,, ,,	Answer reasonably two out of three: "What must you do when you are sleepy?" "What ought you to do when you are cold?" "What ought you to do when you are hungry?"
	20 to 50%.	Copy a square (recognisably) from a model (but not drawn in their presence).
	,, ,, ,,	Provide two oblong cards, one divided by a diagonal cut into two triangles. Child presented with two triangles and asked to "Put them together so that they look exactly like this (pointing to rectangle).' Allow three attempts of 1 minute each. Pass if two of three are successful.
	,, ,, ,,	Give an answer to "What must you do if you have lost something?" which shows that expression 'lost' is fully understood.
	0 to 20%.	Give a correct answer on three out of four 'missing feature' pictures. "What is left out of the face?" (Four pictures of faces as in Binet 7 year. One with mouth, one with nose, one with ear, and one with eye missing.)

The percentages on the left indicate the number of children found by Gesell to pass this test at the age concerned. A child should have the mental age indicated on the left when he passes the tests on which 50% (say 40–60%) of the children of that age succeed. But unfortunately Gesell's norms are not arranged in 50% categories. With the arrangement of items made above a child should pass for a given year when he succeeds in more than a half of the items for that year (except in the Fourth year, when just a half will suffice).

The Measurement of Intelligence in Infants and Pre-school Children. Psyche Cattell, Psychological Corporation, 1940.

ate sorting of junior children. Time required, 45 minutes. Well standardised. Stencil keys. Obtainable from Messrs. G. Harrap & Co.

Sleight. Non-verbal.—Ten short sub-tests of good validity. Age-range 6–11 years. Time required, about 35 minutes (18¼ minutes' testing time, remainder instructions, etc.). Soundly standardised. Obtainable from Messrs. G. Harrap & Co.

Senior and High School School Range: 11–17 *years inclusive*

(Tests for scholarship examinations at 11 years should be chosen from the 11–14 mental age-range, since most scholarship candidates between whom it is desired to distinguish finely fall at a 12–13 mental age.)

American Council on Education Psychological Examination for High School Students.—Companion test to adult form (see below). Designed by L. L. and T. G. Thurstone and revised each year. High validity as tested by internal factorial composition. One hour. Machine scorable. Obtainable Co-operative Test Service (see below).

Cattell Test, Scale II. Verbal with non-verbal items. Group or Individual. Ages 11–15 years. (Quite suitable for average and sub-average adults.)—Six sub-tests, giving 151 pass or fail items. The validity of these individual sub-tests ranges[1] from 0·65 to 0·85. Standardised on 2,070 cases supplied from various parts of Great Britain. Time required, 70 minutes. The first sub-tests have a generous time limit to give subjects a sense of confidence. A and B Forms provided. Preliminary 'practice' test supplied to eliminate 'test sophistication.' The test can be given in a much shortened form requiring 24 minutes and correlating with the full scale[1] 0·88. Stencil key. Obtainable from Messrs. G. Harrap & Co.

Chelsea Tests. (P. B. Ballard.) Verbal ages 11–14 years. Group or Individual.—Four sub-tests giving 100 pass or fail items. First test timed, but others unlimited. Total time therefore varies, but about an hour generally

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[1] Halstead, H., and Chase, V. E., "Review of a Verbal Intelligence Scale on Military Neurotic Patients," *Brit. J. Med. Psychol.*, xx, 195–201, 1944.

suffices. Permits of inventive as well as selective answers. Tentative norms which do not cover low 11- and 12-year-olds or high 13- and 14-year scores. Material and norms in *Group Tests of Intelligence* (Ballard).

Columbia Test. (P. B. Ballard.) Verbal. Ages 10–14.—Six sub-tests. Four or 5 minutes each; two untimed. Tentative norms not extending to mental ages below 10 or above 14. Material in *Group Tests of Intelligence* (Ballard).

Group Test 34. Verbal, with non-verbal items. Group or Individual. Age range 10–15 years.—Nine sub-tests of good validity, giving 200 pass or fail items. Rather large vocabulary demand on two tests. Timed on each sub-test. Total test time, 38 minutes. Well standardised. Available from National Institute of Industrial Psychology.

Moray House Test 10. (Godfrey Thomson.) Verbal. Group or Individual. Ages 10·6–12.—Fifteen sub-tests representing five distinct types of sub-test. 100 items, some on only a two-response basis. Sub-tests not timed. Total time, 45 minutes, plus 10 minutes for a 'shock absorber test.' Very soundly standardised. Available from University of London Press.

Moray House Test IIa. (Godfrey Thomson.) Verbal. Group or Individual. Ages 10·6–12.—An 'omnibus' test, without distinct sub-tests, the instructions being given afresh on each item. Seventy-five items. Forty-five minutes, plus 10 minutes for 'shock absorber' test. Very soundly standardised, over small age range. Available from University of London Press. This test and test 12 were originally twin tests (i.e. A and B Forms), but the latter has been converted into the Scottish Mental Survey Test.

Northox Group Intelligence Test. (G. P. Williams.) Ages 11–12 years.—Five sub-tests, one requiring arithmetical knowledge. Time, 30 minutes. Obtainable from Messrs. G. Harrap & Co.

Northumberland Mental Tests, No. 1. (Godfrey Thomson.) Group or Individual. Verbal. Ages 10–12·6.—Twelve sub-tests. Time required, 1 hour. Very soundly standardised on 2,500 children in Northumberland. Supplied with 10 minutes' practice 'introduction' test. Obtainable from Messrs. G. Harrap & Co.

Northumberland Standardised Tests—III, Intelligence. (Burt.) Group or Individual. Verbal. Ages 10–12, but quite effective a year above and below these limits.—Nine highly valid sub-tests. Time—10 minutes for preliminaries; 1 hour for test. Time limit on each sub-test. Soundly standardised. Obtainable from University of London Press.

Northumberland Mental Tests, No. 2. (Godfrey Thomson.) Group or Individual. Verbal. Ages 12·6 and over.—Fourteen sub-tests, giving 60 pass or fail items. Time, 1 hour, notified every ¼ hour, but no limit on each sub-test. Soundly standardised. Obtainable from Messrs. G. Harrap & Co.

Otis Advanced Test. Verbal. Group or Individual. Ages 10 to about 13.—Ten sub-tests of good validity. Possibly not yet adequately standardised for English children. Results expressed as Indices of Brightness or as Intelligence Quotients. A and B Forms available; also an abbreviated test. Time required, about 1 hour 10 minutes. Obtainable from Messrs. G. Harrap & Co.

Scottish Research Council Mental Survey Test (1932). Verbal and Pictorial. Age range 10–12 years.—Mixed items. One demanding large vocabulary. Time required, 50 minutes. Very soundly standardised (on 87,000 Scottish children). Obtainable from University of London Press.

Simplex Group Test. Group or Individual. Verbal. Age range 10–14 years.—Twenty-six sub-tests. (Rather big vocabulary demand.) Time required, 1 hour. Obtainable from Messrs. G. Harrap & Co.

Spearman's "Measure of Intelligence." Verbal. Booklets not required. Age range 10–14 years.—Seven highly valid sub-tests. Time required, about 1¼ hours. Soundly standardised. (See *Forum of Education*, 1929.) Obtainable from Methuen & Co.

7924

Adult Tests, i.e. 14 *Years and Upwards*

(*Note.*—Most of these tests are better adapted to 'superior adults.' For getting accurate measurements of the lower mental ranges among adults—e.g. among unskilled workers —it is advisable to use tests from 11–14-year ranges. In the case of adult defectives, the 4–8-range, e.g. the Dartington Scale, will be found most effective.)

American Council on Education Psychological Examination for College Freshmen.—Six sections; one hour; yields distinct scores in (1) verbal and (2) quantitative-numerical abilities. Designed by L. L. and T. G. Thurstone. New form published each year. Machine scorable. Obtainable Co-operative Test Service, 15, Amsterdam Avenue, New York.

Cattell Test, Scale III. Verbal with non-verbal items. Group or Individual.—Six highly valid sub-tests, giving 151 pass or fail items. Preliminary practice test. Time required, 1 hour 10 minutes. Time limit for each of subtests. Standardised on 2,000 adults, with additional occupational norms.[1] A and B Forms available. The test can be given in a much shortened form (24 minutes), especially suitable for subjects of limited reading vocabulary. Stencil keys. Obtainable from Messrs. G. Harrap & Co.

Crichton Test. (Dr. Ballard.) Verbal. Group or Individual.—Omnibus test of 28 items. Inventive and selective answers. No time limit. Rough norms. Material in *Group Tests of Intelligence* (Ballard).

Group Test 33. Verbal. Group or Individual.—Five sub-tests. Synonyms require too large a vocabulary for average adult. Time required, 30 minutes. Obtainable from National Institute of Industrial Psychology.

Otis Self-administering Tests of Mental Ability. Higher Examination. Group and Individual.—One test of 75 items. Scored on 20 or on 30 minutes. A useful rough test of short duration. Obtainable from World Book Co., Yonkers, N.Y.

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[1] See "Occupational Norms of Intelligence and Standardisation of an Adult Intelligence Test," *Brit. J. Psychol.*, xv, 1, July 1934.

26.11.93
7608
S.I.B

Stanford-Binet, 1937 revision, has two forms, L and M, as described above, and has had sufficient 'top' added to make a sound test for superior adults, but is still founded on the questionable theory of the original Binet. Obtainable from Houghton Mifflin, Boston.

Wechsler-Bellevue. Age 10 and over. Individual, verbal. —Shares the unsatisfactory theoretical foundation of the Binet and is rather heavily loaded with 'V' factor and general knowledge. Obtainable from Psychological Corporation, Fifth Avenue, New York, 1939.

Tests of very brief duration (and therefore low reliability) are available in the 12-minute Otis and the abridged Otis by Wonderlic (Wonderlic, E., and Hovland, C. I., *J. Appl. Psychol.* xxiii, 685–702, 1939).

Measurement of Deterioration in Intelligence

A special case of the measurement of intelligence is that in which one is measuring the ability of some person in whom, through epilepsy or other psychotic conditions, or even through old age, deterioration is believed to have taken place temporarily or permanently. One wishes to measure both the present intelligence (which can be done in the ordinary way with a suitable 'g' test) and the original level of intelligence. The task of assessing the latter is like reconstructing the dimension of some ancient building from its present ruins. Size of vocabulary is known to correlate closely with intelligence among people of reasonably similar education. The researches of Simmins,[1] Babcock,[2] Shipley, Davies Eysenck,[3] and others show that the vocabulary, at least in patches, persists at its original degree of elaborateness after intelligence has gravely declined. Score on a suitable vocabulary test, therefore, is the best means yet known to determine what ability a person once had. The research of Davies Eysenck[3] and the inquiries of the present writer[1] indicate that the measurement of intelligence where deterioration has occurred is best handled by the concepts of 'fluid and crystallised ability,'[2] according to which *two* scores are finally used to define the individual's general ability.

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[1] Constance Simmins, "Deterioration of 'g' in Psychotic Patients," *J. Mental Sci.*, October, 1933.

[2] E. Babcock, "An Experiment in the Measurement of Mental Deterioration," *Arch. of Psychol.*, No. 117, N.Y., 1930.

[3] M. Davies Eysenck, "An Exploratory Study of Mental Organisation in Senility," *J. of Neurol. and Psychiat.*, viii, 15–22, 1945.

The Terman Vocabulary Test, being standardised for adults, was used in the above researches, but other suitable tests will be found in the vocabulary section of "Attainment Tests," though they will need to be standardised afresh for this purpose—namely, in relation to I.Q.s among adults.

(ii) *Other Tests (Not Detailed)*

Measurement of Intelligence by Drawings (F. L. Goodenough).—Owing to the very large specific factor in drawing ability, it is not a means by which one would normally choose to estimate intelligence. Scored in the particular manner worked out by Goodenough, however, correlations as high as ·76 with intelligence may be obtained. For details, see Special Aptitudes, p. 62, of next chapter.

Bristol Group Reasoning Tests. (Dr. Barbara Dale.)—Inferences only. Well graded. A test which has been shown to involve a rather extensive special ability.[2] University of London Press.

Evesham Intelligence Test. (Dr. Haselhurst, Grammar School, Evesham.)

Leeds Intelligence Test. (Dr. Terry Thomas.)—Nos. 1–4 for boys of 11 plus. Extension for 15-16 years. Bell & Co.

Oxton Group Intelligence Test. (G. P. Williams.)—For children of 11–14. Mainly general knowledge, as devised for certain Education Committees.

Porteus Maze Tests. Individual. Paper mazes, 6–15 years, one for each year. Excellent for inter-cultural comparisons, but involve a personality stability factor additional to intelligence.

Tomlinson's "West Riding Tests of Mental Ability."—

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[1] Cattell, R. B., "The Measurement of Adult Intelligence," *Psychol. Bull.*, xl, 153–93, 1943.

[2] See Spearman's *Abilities of Man*, p. 225, for summary of evidence.

NORMS FOR CATTELL

READY RECKONER FOR

Score on Complete Test		10	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46
Score on Abbreviated Form		8	10	11	12	14	15	16	17	18	19	20	21	22	23	25	26	27	28
Actual Age of Child in Years and Months	4.0	84	90	94	97	100	103	106	110	113	117	120	123	127	131	135	139	143	148
	.6	75	80	83	86	89	92	95	98	101	104	107	110	113	116	120	123	126	131
	5.0	67	72	74	77	80	83	86	89	91	94	96	99	102	105	108	111	114	118
	.6	61	65	68	70	73	75	78	80	82	85	88	90	93	95	98	101	104	107
	6.0	56	60	63	65	67	69	71	73	75	78	80	82	85	87	90	92	95	98
	.6	51	55	57	59	61	63	65	68	70	72	74	76	78	80	83	86	88	91
	7.0		51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	82	84
	.6					53	55	57	59	61	63	65	66	68	70	72	74	76	79
	8.0					50	51	53	55	57	59	61	62	64	66	68	70	72	74
	.6								52	53	55	57	58	60	62	64	66	67	69
	9.0										52	53	55	57	59	60	62	64	66
	10.0													51	52	54	56	57	59
	11.0															49	50	52	54
Adults 15 +																40	41	43	44

Pick out the column which bears the score and the row marked by the age of

SCALE O (DARTINGTON SCALE)

CALCULATING INTELLIGENCE QUOTIENTS

48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90
29	30	32	33	34	36	37	38	40	41	43	44	46	47	49	51	52	54	55	56	57	59
152	157	161	164																		
135	140	144	148	153	158	164	169														
122	127	131	134	138	143	148	153	158	164												
111	115	118	121	125	128	134	139	144	150	155	161	167									
101	105	108	111	115	119	123	128	132	137	142	147	152	158	165							
93	97	100	103	106	110	114	118	122	126	131	136	141	146	152	158	164	170				
87	90	93	96	99	102	106	110	113	117	122	127	132	137	141	146	152	158	164	170		
81	84	87	89	92	96	99	102	105	109	114	118	122	127	132	137	142	147	153	159	165	171
76	79	81	84	86	89	93	96	99	103	107	111	115	119	124	128	133	138	144	149	155	160
72	74	76	79	81	83	87	90	93	97	100	104	108	112	116	120	125	130	135	140	145	150
68	70	72	75	77	79	82	85	88	91	95	99	103	107	110	114	119	123	127	132	137	142
61	63	65	67	69	71	74	76	79	82	85	88	91	95	99	103	106	110	115	119	123	128
56	57	59	61	63	65	67	69	72	75	77	80	83	86	90	93	97	100	104	108	112	116
46	47	49	51	53	54	55	56	57	58	59	62	64	66	69	71	73	75	77	79	81	84

the person tested. At their junction will be found his intelligence quotient.

NORMS FOR

Directions.—Pick out the column which bears the score and the row marked by the
the examinee expressed in

SCORE

AGE IN YEARS

FORM A	16	20	23	25	26	27	28	29	30	31	32	33	34	35	36	37	38
FORM B	20	25	29	31	32	33	34	35	36	37	38	39	40	41	42	43	44
7 (6·9–7·2)	86	93	97	100	101	103	105	106	107	109	110	111	112	113	114	115	115
7½ (7·3–7·8)	80	87	91	94	95	96	97	99	100	102	103	104	104	105	106	106	108
8 (7·9–8·2)	75	81	85	88	89	90	91	93	94	95	96	97	98	99	100	100	101
8½ (8·3–8·8)	71	77	80	83	84	85	86	87	88	90	91	92	92	93	94	95	96
9 (8·9–9·2)	67	73	76	78	79	80	81	82	84	85	86	87	87	88	89	89	90
9½ (9·3–9·8)	63	68	71	75	75	76	77	78	79	80	81	82	83	83	84	84	85
10 (9·9–10·2)	60	65	68	70	71	72	73	74	75	76	77	78	78	79	80	80	81
10½ (10·3–10·8)	57	62	65	67	68	69	70	71	71	72	73	74	74	75	76	76	77
11 (10·9–11·2)	55	59	62	64	65	65	66	67	68	69	70	71	71	72	73	73	74
11½ (11·3–11·8)	52	56	59	61	62	63	64	65	65	66	67	68	68	69	70	70	71
12 (11·9–12·2)	50	54	57	58	59	60	61	62	63	64	64	65	65	66	67	67	68
12½ (12·3–12·8)		52	54	56	57	57	58	59	60	61	62	62	63	63	64	64	65
13 (12·9–13·2)		50	52	54	55	56	56	57	58	59	59	60	60	61	61	62	62
14 (13·9–14·2)			45	50	51	52	52	53	53	54	55	56	56	57	57	57	58
Adults (17·9–)																57	58

FORM A	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
FORM B	61	62	62	63	64	65	66	67	67	68	69	70	71	72	73	74	75
7 (6·9–7·2)	141	142	143	144	145	147	149	152	154	157	159	161	163	165	167	170	173
7½ (7·3–7·8)	131	132	133	134	136	137	139	141	143	145	148	150	152	154	156	159	162
8 (7·9–8·2)	123	124	125	126	127	128	130	133	135	137	139	141	142	144	146	149	152
8½ (8·3–8·8)	116	117	118	119	120	121	123	125	127	128	130	132	134	136	138	140	142
9 (8·9–9·2)	109	110	111	112	113	114	116	118	119	121	123	125	126	127	129	132	135
9½ (9·3–9·8)	103	104	105	106	107	108	110	112	114	115	117	118	120	121	123	125	127
10 (9·9–10·2)	98	99	100	101	102	103	105	106	107	109	111	112	113	115	117	119	121
10½ (10·3–10·8)	93	94	95	96	97	98	100	101	103	105	106	107	108	109	111	113	115
11 (10·9–11·2)	89	90	91	92	94	95	96	97	99	100	101	102	104	105	107	108	110
11½ (11·3–11·8)	86	87	88	89	90	90	91	92	93	95	96	97	99	100	102	103	105
12 (11·9–12·2)	82	83	84	85	86	87	88	89	90	91	92	93	95	96	97	99	101
12½ (12·3–12·8)	78·6	79	80	81	81·6	82	84	85	86	87	89	90	91	92	93	95	97
13 (12·9–13·2)	75	76	77	78	78	79	80	82	83	83	85	86	87	88	90	91	93
14 (13·9–14·2)	70	71	72	72	73	74	75	76	77	78	79	80	81	82	83	84	85
Adults (17·9–)	67	68	69	69	70	71	72	73	73	74	75	75	76	77	78	79	80·6

This standardisation is based on measurements of some 1,200 persons as described
elementary and secondary school scores, as described

SCALE I

age of the person tested. At their junction will be found the intelligence quotient of relation to a normal of 100.

39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	**FORM A**
45	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**FORM B**
117	119	120	122	123	125	126	128	129	131	132	133	135	136	137	139	**7** (6·9–7·2)
109	110	112	113	115	116	117	119	120	122	123	124	126	127	128	129	**7½** (7·3–7·8)
102	104	105	106	107	109	110	111	112	114	115	116	117	119	120	122	**8** (7·9–8·2)
97	98	99	100	101	103	104	105	106	107	108	109	110	112	113	114	**8½** (8·3–8·8)
91	92	93	94	95	96	98	99	100	101	102	103	104	105	106	108	**9** (8·9–9·2)
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	**9½** (9·3–9·8)
82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	**10** (9·9–10·2)
78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	**10½** (10·3–10·8)
75	75	76	77	78	79	80	81	82	83	84	84	85	86	87	88	**11** (10·9–11·2)
72	73	73	74	75	76	77	77	78	79	80	81	82	83	84	85	**11½** (11·3–11·8)
69	69	70	71	72	72	73	74	75	76	77	77	78	79	80	81	**12** (11·9–12·2)
66	66	67	68	69	70	70	71	72	73	74	74	75	76	77	78	**12½** (12·3–12·8)
63	64	65	65	66	67	68	68	69	70	71	71	72	73	74	75	**13** (12·9–13·2)
59	59	60	61	61	62	63	63	64	65	66	66	67	68	69	69	**14** (13·9–14·2)
58	59	60	61	61	61	62	62	63	64	65	65	66	66	66	67	**Adults** (17·9–)

72	73	74	75	76	77	78	79	81	83	86	89	93	97	101	105	**FORM A**
76	**77**	**78**	**79**	**80**	**81**	**82**	**84**	**85**	**87**	**90**	**93**	**97**	**100**	**104**	**108**	**FORM B**
																7 (6·9–7·2)
165	168															**7½** (7·3–7·8)
155	158	161	164	167												**8** (7·9–8·2)
145	148	151	154	158	162	167										**8½** (8·3–8·8)
137	140	143	146	149	153	158	168									**9** (8·9–9·2)
130	133	136	138	141	145	150	159	168								**9½** (9·3–9·8)
123	126	129	131	134	137	142	151	160	170	176	179					**10** (9·9–10·2)
117	120	123	125	128	131	135	144	152	162	167	170	181				**10½** (10·3–10·8)
112	115	117	119	122	125	129	137	145	155	160	163	173				**11** (10·9–11·2)
107	109	111	114	117	120	123	131	139	148	152	155	165	185			**11½** (11·3–11·8)
103	105	107	110	112	115	118	126	134	142	147	149	158	176			**12** (11·9–12·2)
99	100	102	105	107	110	113	121	128	136	141	143	152	170			**12½** (12·3–12·8)
95	97	99	100	104	106	109	116	123	131	136	138	146	163			**13** (12·9–13·2)
87	90	92	94	96	98	101	108	114	121	126	128	131	152	190		**14** (13·9–14·2)
81	83	84	85	88	88	90	95	100	103	107	109	113	123	143	154	**Adults** (17·9–)

elsewhere. The typical population is reconstructed from a combination of in the *Brit. J. Psychol.*, January 1936.

NORMS FOR

AGE IN YEARS	SCORE																	
FORM A	39	41	44	47	52	55	58	61	64	67	69	71	73	74	75	76	77	78
FORM B	40	42	45	48	53	57	60	63	65	69	71	73	75	76	77	78	79	80
7½ (7·3–7·8)	93	100	106	113	120	123	127	130	134	137	140	144	147	149	151	153	156	158
8½ (8·3–8·8)	83	88	94	100	106	109	112	115	118	122	124	126	129	131	134	136	138	139
9½ (9·3–9·8)	73	79	84	89	95	97	100	103	105	108	110	113	116	118	119	121	123	125
10½ (10·3–10·8)	.67	72	76	81	86	88	90	93	95	98	100	102	105	106	108	110	111	113
11 (10·9–11·2)	64	68	73	77	82	84	86	88	91	94	96	98	100	101	103	104	106	108
11½ (11·3–11·8)	62	66	69	74	78	80	82	85	87	89	91	93	96	98	99	100	101	103
12 (11·9–12·2)	58	63	67	72	75	77	79	82	84	86	87	89	91	92	94	96	98	99
12½ (12·3–12·8)	56	60	64	68	72	74	76	78	80	82	84	86	88	89	91	92	93	95
13 (12·9–13·2)	54	58	62	65	69	71	73	75	77	79	81	83	85	.86	87	88	89	91
13½ (13·3–13·8)	52	56	59	63	67	69	71	72	74	76	78	79	82	83	84	85	86	88
14 (13·9–14·2)	50	54	57	61	64	66	68	70	72	74	75	77	79	80	81	82	83	85
14½ (14·3–14·8)	50	54	57	60	63	64	66	67	69	71	72	74	76	77	78	79	80	82
15 (14·9–15·2)	50	54	57	60	63	64	66	67	69	71	72	73	74	75	76	77	78	79
15½ (15·3–15·8)	50	54	57	60	63	64	66	67	69	71	72	73	74	75	76	77	78	79
16 (15·9–16·2)	50	54	57	· 60	63	64	66	67	69	71	72	73	74	75	76	77	78	79
Adults (17·9–)	50	54	57	60	63	64	66	67	69	71	72	73	74	75	76	77	78	79

FORM A	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
FORM B	98	99	100	101	101	102	103	104	105	106	107	108	109	·110	111	112	113	114
7½ (7·3–7 8)																		
8½ (8·3–8·8)																		
9½ (9·3–9·8)	162	163	166	169	171	173	174											
10½ (10·3–10·8)	147	148	150	153	155	156	157	159	161	162	164	165	167	168	170	172		
11 (10·9–11·2)	140	141	143	145	147	149	150	152	153	155	156	157	159	160	162	163	165	166
11½ (11·3–11·8)	134	135	137	139	141	142	144	146	147	148	149	150	152	153	154	156	157	159
12 (11·9–12·2)	128	129	131	133	135	136	138	139	140	142	143	144	145	146	148	150	152	153
12½ (12·3–12·8)	123	124	126	128	130	131	132	134	135	136	137	138	140	141	143	144	146	147
13 (12·9–13·2)	118	119	121	123	125	126	127	129	130	131	132	133	135	136	137	139	140	141
13½ (13·3–13·8)	114	115	117	119	120	121	122	123	124	125	127	128	130	131	132	133	134	135
14 (13·9–14·2)	110	111	113	114	115	117	119	119	120	121	122	123	125	126	127	129	130	131
14½ (14·3–14·8)	106	107	109	110	112	113	114	115	116	117	118	119	121	122	123	124	125	126
15 (14·9–15·2)	102	103	105	107	108	109	110	111	113	114	115	116	117	118	119	120	121	122
15½ (15·3–15·8)	99	100	102	103	104	105	107	108	109	110	111	112	113	114	115	116	117	118
16 (15·9–16·2)	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	113	114	115
Adults (17·9–)	97	98	99	100	101	102	102	103	104	105	106	107	107	108	109	109	110	111

This standardisation is based on measurements of some 2,700 people, sampled from
J. Psychol., January 1936. The principle of the 'shifting denominator' (as
The psychometrist should note that from the score of 114 and upwards

SCALE II

79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	**FORM A**
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	**FORM B**
160	162	164	167	169	171	174											**7½** (7·3–7·8)
141	143	145	147	149	151	153	155	157	159	161	163	165	168	171			**8½** (8·3–8·8)
127	129	130	132	134	135	137	139	141	142	144	145	147	150	152	158	160	**9½** (9·3–9·8)
114	116	117	119	121	122	124	125	127	128	130	131	133	136	138	143	145	**10½** (10·3–10·8)
109	111	112	114	115	117	118	120	121	123	124	126	127	130	134	136	138	**11** (10·9–11·2)
104	106	107	109	110	112	113	115	116	118	119	121	122	124	126	130	132	**11½** (11·3–11·8)
100	102	103	104	105	106	108	109	111	112	113	115	117	119	121	125	127	**12** (11·9–12·2)
96	98	99	100	101	103	104	105	107	108	109	111	112	114	116	120	122	**12½** (12·3–12·8)
92	94	95	96	97	99	100	102	103	104	105	107	108	110	111	115	117	**13** (12·9–13·2)
89	91	92	93	94	95	96	98	99	100	101	103	104	105	107	111	113	**13½** (13·3–13·8)
86	88	88	89	90	92	93	94	95	96	97	99	100	102	104	107	109	**14** (13·9–14·2)
83	84	85	86	87	89	90	91	92	93	94	96	97	99	100	103	105	**14½** (14·3–14·8)
80	81	82	83	84	86	87	88	89	90	91	92	93	95	97	100	101	**15** (14·9–15·2)
80	81	82	83	84	85	86	87	87	88	89	90	90	91	93	96	97	**15½** (15·3–15·8)
80	81	82	83	84	85	86	87	87	88	89	90	90	91	93	95	96	**16** (15·9–16·2)
80	81	82	83	84	85	86	87	87	88	89	90	90	91	93	95	96	**Adults** (17·9–)

114	115	116	117	118	119	121	125	127	130	133	136	139	142	145	147	148	**FORM A**
115	116	117	118	119	120	122	126	128	130	133	136	139	142	145	147	148	**FORM B**
																	7½ (7·3–7·8)
																	8½ (8·3–8·8)
																	9½ (9·3–9·8)
																	10½ (10·3–10·8)
168	169	169	170	171													**11** (10·9–11·2)
161	162	162	163	164	164	166	170	172	174								**11½** (11·3–11·8)
155	156	156	157	157	157	160	163	165	167	170							**12** (11·9–12·2)
148	149	149	150	150	150	152	156	158	160	164	168	172					**12½** (12·3–12·8)
142	143	144	145	145	145	147	150	152	154	158	161	165	167	170	172	173	**13** (12·9–13·2)
137	138	138	139	139	139	142	145	146	148	152	156	159	161	164	166	167	**13½** (13·3–13·8)
132	133	133	134	134	135	137	140	142	143	146	150	154	156	159	160	161	**14** (13·9–14·2)
127	128	129	129	130	130	132	135	137	138	141	144	148	150	153	154	155	**14½** (14·3–14·8)
123	124	124	125	125	125	127	130	132	133	137	140	144	146	148	149	150	**15** (14·9–15·2)
119	120	120	121	121	122	124	126	127	129	132	135	139	141	143	144	145	**15½** (15·3–15·8)
116	117	117	118	118	118	120	122	123	125	128	131	134	136	138	140	141	**16** (15·9–16·2)
111	112	112	113	113	113	114	116	117	118	120	122	124	126	126	127	128	**Adults** (17·9–)

elementary and secondary school children in Great Britain, as described in the *Brit.*
described for Scale III) has been employed on the upper reaches of intelligence.

these norms are modified from those in the earlier edition of this book.

NORMS FOR

SCORE

AGE IN YEARS

FORM A	29	31	35	38	42	44	46	48	50	52	54	56	58	60	61	62	63	64
FORM B	**39**	**41**	**43**	**45**	**48**	**50**	**51**	**52**	**54**	**56**	**58**	**60**	**62**	**64**	**65**	**66**	**67**	**68**
12½ (12·3–12·8)	58	64	68	72	80	88	92	96	100	104	108	112	116	118	120	124	128	132
13 (12·9–13·2)	55	61	65	69	77	85	88	92	96	100	104	108	111	113	115	120	123	127
13½ (13·3–13·8)	53	59	63	66	74	81	85	89	92	96	100	104	107	109	111	115	118	122
14 (13·9–14·2)	50	57	60	64	72	78	82	85	89	93	96	100	103	105	107	110	114	118
14½ (14·3–14·8)	50	57	60	64	70	75	79	82	86	89	93	96	100	102	103	107	111	114
15 (14·9–15·2)	50	57	60	64	70	75	79	80	83	85	90	93	96	98	100	103	106	110
15½ (15·3–15·8)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	103	106
16 (15·9–16·2)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103
16½ (16·3–16·8)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103
17 (16·9–17·2)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103
17½ (17·3–17·8)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103
18 (17·9–18·2)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103
18½ (18·3–18·8)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103
19 (18·9–19·2)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103
19½ (19·3–19·8)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103
20 (19·9–20·2)	50	57	60	64	70	75	79	80	83	85	87	90	93	95	97	99	101	103

FORM A	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
FORM B	**84**	**85**	**86**	**87**	**88**	**88**	**89**	**90**	**91**	**91**	**92**	**93**	**94**	**94**	**95**	**96**	**97**	**97**
12½ (12·3–12·8)	178																	
13 (12·9–13·2)	171	173	175	177														
13½ (13·3–13·8)	164	166	168	170	172	174	177											
14 (13·9–14·2)	158	161	163	164	166	168	171	173	175	176	178							
14½ (14·3–14·8)	153	155	157	158	160	162	165	166	168	170	172	174	177					
15 (14·9–15·2)	148	151	152	153	155	157	160	161	163	163	166	168	171	173	174	175	176	177
15½ (15·3–15·8)	143	145	146	148	150	152	154	156	158	160	162	163	165	167	168	169	170	172
16 (15·9–16·2)	139	141	142	143	145	147	150	151	153	154	156	158	160	162	163	164	165	166
16½ (16·3–16·8)	135	136	138	139	140	142	145	146	148	149	151	153	155	157	158	159	160	161
17 (16·9–17·2)	131	133	134	135	136	137	141	142	144	145	146	149	151	153	154	155	156	157
17½ (17·3–17·8)	127	128	129	130	131	132	136	138	140	141	142	144	145	148	149	150	151	152
18 (17·9–18·2)	127	128	129	130	131	132	133	134	135	136	137	138	139	143	145	146	147	148
18½ (18·3–18·8)	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
19 (18·9–19·2)	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
19½ (19·3–19·8)	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
20 (19·9–20·2)	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144

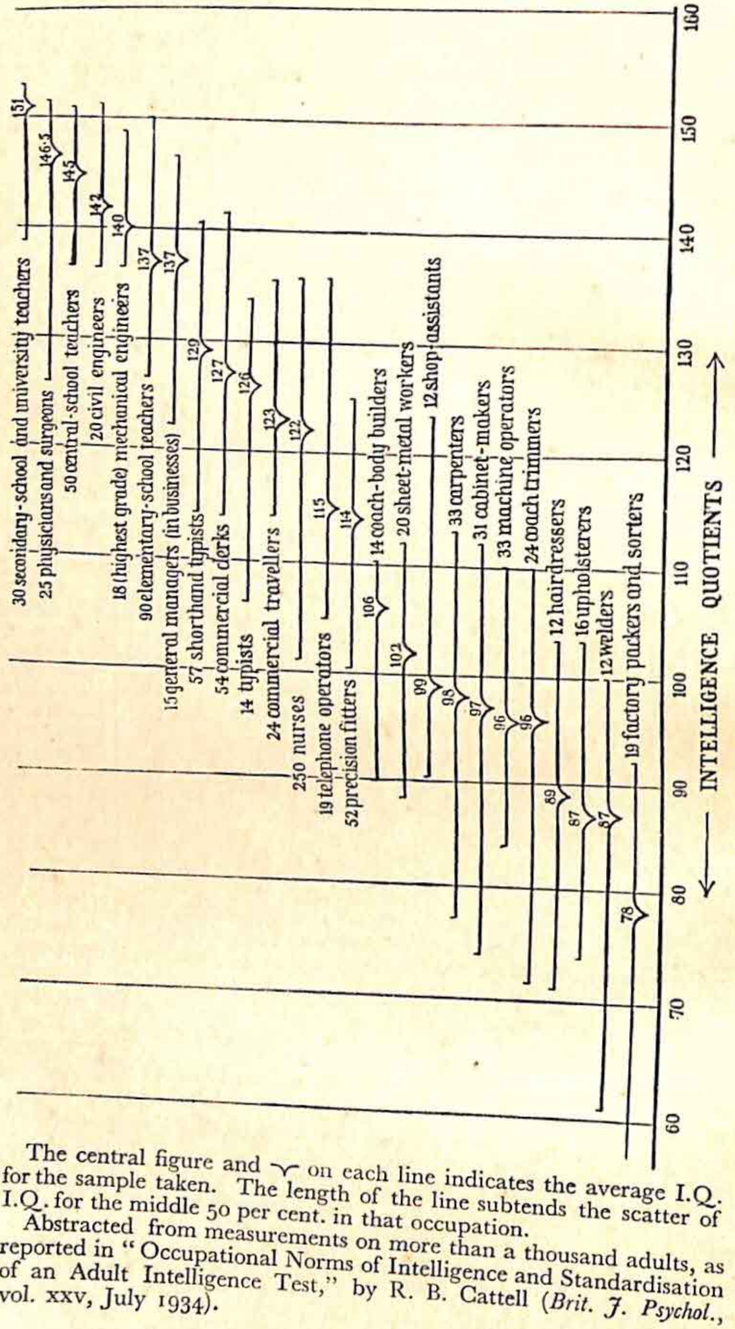
This table is based on norms from over 2,000 adults, sampled from a variety of occupations.
and Standardisation of an Adult Intelligence Test," by R. B. Cattell (*Brit. J. Psychol.*,
developing a little longer with children of higher intelligence, so that there is a

SCALE III

65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80		FORM A
69	70	71	72	73	74	75	76	77	78	78	79	80	81	82	83		FORM B
136	139	141	144	146	150	154	156	159	162	164	166	168	170	172	176		12½ (12·3–12·8)
130	133	136	138	141	143	146	149	153	155	157	159	161	164	166	170		13 (12·9–13·2)
126	128	130	133	135	139	140	144	148	149	151	153	155	157	160	163		13½ (13·3–13·8)
121	124	126	128	130	133	135	139	143	144	146	148	150	152	154	157		14 (13·9–14·2)
117	119	121	124	126	128	131	134	138	139	141	142	144	146	148	151		14½ (14·3–14·8)
113	115	117	120	122	124	126	129	132	134	136	138	140	142	144	146		15 (14·9–15·2)
109	111	113	115	117	120	122	125	128	130	132	133	135	137	139	141		15½ (15·3–15·8)
105	106	108	111	114	116	118	120	124	126	128	129	131	133	135	137		16 (15·9–16·2)
105	106	108	109	110	111	113	115	120	122	124	125	127	129	131	133		16½ (16·3–16·8)
105	106	108	109	110	111	113	115	117	119	120	121	122	123	125	129		17 (16·9–17·2)
105	106	108	109	110	111	113	115	117	119	120	121	122	123	125	126		17½ (17·3–17·8)
105	106	108	109	110	111	113	115	117	119	120	121	122	123	125	126		18 (17·9–18·2)
105	106	108	109	110	111	113	115	117	119	120	121	122	123	125	126		18½ (18·3–18·8)
105	106	108	109	110	111	113	115	117	119	120	121	122	123	125	126		19 (18·9–19·2)
105	106	108	109	110	111	113	115	117	119	120	121	122	123	125	126		19½ (19·3–19·8)
105	106	108	109	110	111	113	115	117	119	120	121	122	123	125	126		20 (19·9–20·2)

99	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	FORM A
98	99	100	102	105	106	108	110	112	113	115	117	118	120	122	125	127	FORM B
																	12½ (12·3–12·8)
																	13 (12·9–13·2)
																	13½ (13·3–13·8)
																	14 (13·9–14·2)
																	14½ (14·3–14·8)
																	15 (14·9–15·2)
174	176	178															15½ (15·3–15·8)
168	171	174	176	178													16 (15·9–16·2)
163	165	167	169	172	174	176	177	178									16½ (16·3–16·8)
158	160	163	166	168	169	171	172	173	174	175	176	177	178				17 (16·9–17·2)
154	156	159	161	163	164	166	167	168	169	170	171	172	173	174	175		17½ (17·3–17·8)
150	152	154	156	158	160	162	163	164	165	166	167	168	169	170	171	172	18 (17·9–18·2)
145	146	147	148	149	154	157	158	159	160	161	162	163	164	165	166	167	18½ (18·3–18·8)
145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	19 (18·9–19·2)
145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	19½ (19·3–19·8)
145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	20 (19·9–20·2)

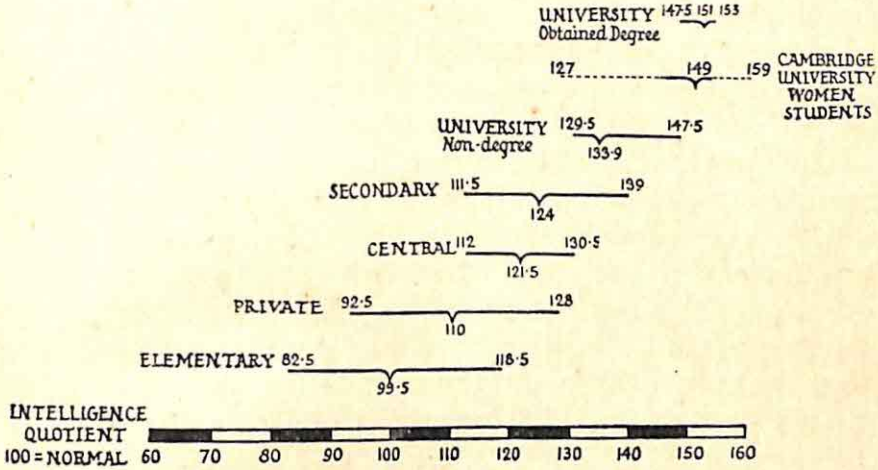
The manner of its derivation is explained in “Occupational Norms of Intelligence,
vol. xxv, July 1934). It embodies the notion that intelligence goes on
‘shifting denominator’ to the I.Q. between 14 and 19 years of age.



INTELLIGENCE LEVELS IN VARIOUS OCCUPATIONS (FOR PURPOSES OF VOCATIONAL GUIDANCE)

The central figure and ⋎ on each line indicates the average I.Q. for the sample taken. The length of the line subtends the scatter of I.Q. for the middle 50 per cent. in that occupation.

Abstracted from measurements on more than a thousand adults, as reported in "Occupational Norms of Intelligence and Standardisation of an Adult Intelligence Test," by R. B. Cattell (*Brit. J. Psychol.*, vol. xxv, July 1934).



INTELLIGENCE RELATING TO EDUCATIONAL GROUP

Highly valid sub-tests. Standardised. University of London Press.

Wiltshire Intelligence Tests.—(Not published for general use.) (Prof. Hamley and Dr. Philpott.)—A test based on recent research towards non-linguistic sub-tests. Institute of Education, London.

(B) PERFORMANCE TESTS

As already indicated, the term ' performance test ' is used to cover a great variety of intelligence tests whose only common feature is that they require apparatus. Yet logically and psychologically they may sometimes present just the same situation as paper tests. For example, the Healy Picture Completion Tests, in which wooden pieces cut out of a picture pasted on a board have to be put back again, is not different from several tests classified with the paper tests above in which the subject indicates with a stroke of the pencil where necessary items from a picture should be replaced.

Nevertheless, it is a proven fact[1] that, especially with young children, greater interest is spontaneously aroused by the performance type of test. Unfortunately the great majority of performance tests have quite low and even negligible correlations with intelligence.

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[1] " Intelligence Tests of Children of 4–8 years," *Brit. J. Educ. Psychol.*, i. See also " The Use of Performance Tests of Intelligence in Vocational Guidance," *J. Inst. Indus. Psych.*, xxix, 4.

The only homage that current practice pays to research findings is the convention that one shall not calculate intelligence quotients from performance tests—since the briefest experience shows that such intelligence quotients are anything but constant. The score is therefore always left as a mental age. In the case of those few performance tests that are highly valid tests of intelligence, no attention should be paid to this convention, and the usual I.Q. is best used.

Until the recent progress in temperament and character research has made itself felt in applied tests, there will still be good reason for using performance tests of even poor 'g' validity—because of the insight they give into temperament and character reactions in face of opportunities, difficulties, and frustrations.[1] The readiness of a child to get angry or to give up; the planfulness shown in moving the blocks in the Passalong test; the tendencies to excitability and impulsiveness in the Seguin Form Board; the confidence or hesitation in Knox's cube movements; the absence of self-criticism and foresight in maze tests, are revelations very helpful to the psychologist in getting at the root of a behaviour problem. Even the mental age itself, or rather its comparison with the mental age on a good (non-verbal) paper test, gives valuable evidence. A relatively high score on the Seguin board is definitely associated with, among other factors, high 'g,' i.e. general strength of character (see p. 213). In many performance tests, however, the discrepancies between true mental age and apparent mental age on the performance test are more often due to special aptitudes, mechanical aptitude, or manual dexterity.

There are, as has been indicated, innumerable performance tests available (Healy, Bronner, Low, and Shimberg, for example, record 100), and many of them have been developed for limited purposes in vocational guidance, or nursery schools, or from some enthusiastic personnel manager's inner consciousness, without 'g' validation, without norms, and without research in regard to effective methods of scoring.

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[1] See e.g. "Interpretation of Reactions to the Pintner-Paterson Performance Scale," by E. M. Wires, *J. Educ. Res.*, 1931, xxiv, 53.

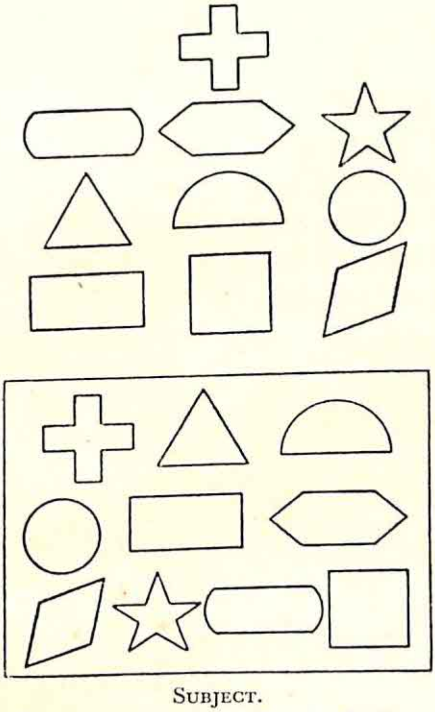

FIG. 1.—Seguin Form Board: Positions of Pieces in Three Heaps Ready for Re-insertion.

I shall therefore give full descriptions, norms, etc., only for a few tests of good validity which will provide the average psychologist with all he needs for most occasions. This section is followed by another merely listing, without detailed descriptions, most other important performance tests. The use of these can be read up in such books as Pintner and Paterson: *A Scale of Performance Tests*; or Healy, Bronner, Low, and Shimberg: *A Manual of Mental Tests and Testing.*

(i) *Test Material Available* (*Detailed*)

The Seguin (also called, when slightly modified, the *Goddard*) *Form Board* should be arranged to face the subject, as shown on p. 35. The pieces are placed in three heaps (not spread out) at the back of the board in the particular order indicated. The subject is told to replace the pieces as quickly as possible (using either or both hands). He does this three times, and is timed with a stop-watch on each trial. The result can be scored either on time or on time and errors. Since the judgment of errors is somewhat subjective, and since no better 'g' correlation results from including them, the time score alone is generally taken. This may be either the average of the three trials or the shortest of three. Probably the latter system is slightly better, since it relates itself to quickness of learning.

Norms.—There are two main sources of norms for this test: those obtained by Gaw and given in the *Industrial Fatigue Research Board Report*, No. 31, and those obtained on still bigger samples by Arthur[1] in America. The figures are practically identical over the 5–10-year range, but thereafter Earle's and Gaw's results give decidedly shorter times. This is of little importance, since the test is in any case not a good one in that upper range. The norms below are compounded of these two standards, and are further slightly modified in accordance with some additional results for which the writer is indebted to P. E. Vernon. Since this test is probably most diagnostic between 2½ years and 6 years, it is a pity that norms are lacking at this lower limit. The present writer has attempted to remedy this matter contingently by collecting scores from 3½- and 4½-year-old elementary nursery-class boys and girls, which have been averaged and included in the table below, producing a further modification (reduction) of times.

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[1] *A Point Scale of Performance Tests*, by G. Arthur, N.Y.

Norms

Mental Age		3½	4	4½	5	5½	6	6½	7	7½
Shortest of 3 trials (secs.) .		56	46	40	35	31	27	25	23	21½
Total of 3 trials (secs.) . .		216	161	133	123	114	105	98	90	83
Mental Age . . .	8	8½	9	9½	10	10½	11	11½	12	12½
Shortest of 3 trials (secs.)	20	19	18½	17½	16½	16	15	14½	14	13½
Total of 3 trials (secs.) .	77	72	68	64	61	58	55	52	49	46
Mental Age . . .	13	13½	14	14½	15	16	17	18	19	20
Shortest of 3 trials (secs.)	13	12½	12½	12	12	11½	11	10½	10½	10
Total of 3 trials (secs.) .	43	41	39	37	36	35	35	34	34	34

The Seguin Form Board is a fairly valid 'g' test only below mental ages of about 10 (i.e. with children and adult feeble-minded). With greater capacities, in accordance with Spearman's "Law of Diminishing Returns," it becomes only a test of manual dexterity. Obtainable from Messrs. Stoelting, Chicago.

Ferguson Form Board.—A much more difficult Form Board suitable for older children and adults. A graduated series of six boards, the pieces in five of which are divided into two sections and otherwise complicated. Continue until subject fails on two consecutive boards. Present so that no two pieces belonging together are in juxtaposition. Time limit for each board, 5 minutes.

Score.—Record time on each board. Convert time into score according to table on p. 38, and then convert score to mental age according to second table.

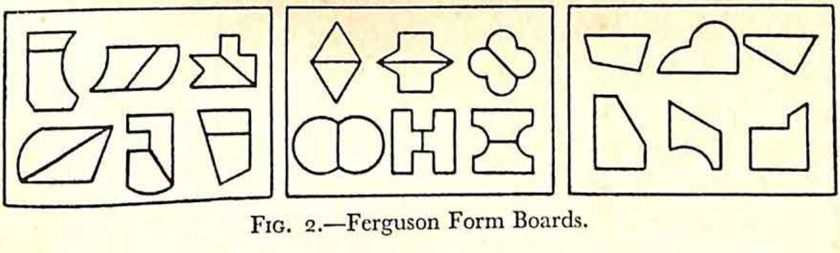

Fig. 2.—Ferguson Form Boards.

For critical examination of its value see E. D. MacPhee and A. J. Brown: "An Enquiry into the Standardisation of the Ferguson Form Boards," *J. Educ. Psychol.*, xxx, 21. Found reliable, but increases of score not much related to mental age and low correlations with intelligence tests. Obtainable from Messrs. Stoelting.

FERGUSON FORM BOARD

TABLE

Values.		10	9	8	7	6	5	4	3	2	1	0
Board I.	Time in Seconds	0 to 16	17 to 19	20 to 21	22 to 24	25 to 27	28 to 29	30 to 36	37 to 51	52 to 66	67 to 300	F
Board II.	,,	0 to 68	69 to 72	73 to 76	77 to 81	82 to 86	87 to 89	90 to 92	93 to 97	98 to 104	105 to 300	F
Board III.	,,	0 to 79	80 to 88	89 to 95	96 to 102	108 to 112	113 to 127	128 to 144	145 to 163	164 to 186	187 to 300	F
Board IV.	,,	0 to 117	118 to 130	131 to 140	141 to 155	156 to 178	179 to 197	198 to 205	206 to 208	209 to 212	213 to 300	F
Board V.	,,	0 to 167	168 to 181	182 to 197	198 to 216	217 to 232	233 to 242	243 to 253	254 to 264	265 to 271	272 to 300	F
Board VI.	,,	0 to 223	224 to 248	249 to 262	263 to 267	268 to 269	270 to 272	273 to 277	278 to 285	286 to 294	295 to 300	F

NORMS: VALUES INTO MENTAL AGES

Sex.	*Age:* 9	10	11	12	13	14	15	16
M. . . .	12	18	24	30	36	42	48	54
F. . . .	12	18	24	30	36	34	38	41

Leake-Smith Figure Board.—A more complex board with 12 holes and 3 or more coloured insets for each. These insets are also presented on a standard 'lay-out' board. Instructions as for other form boards except "All pieces go into holes the same colours as themselves." Quick test for colour blindness should precede test. Three minutes required. Score by number of holes completed. Details of board, together with rough norms, in *The Scientific Selection and Training of Workers in Industry and Commerce*, by M. Martin-Leake and Thyra Smith (Pitmans).

Knox Cube Imitation Test.—Material required: Five oneinch cube blocks of the same colour and material. Four are placed in a row in front of the subject, about two inches apart.

SUBJECT
4 3 2 1
EXAMINER

The examiner, holding the fifth cube in his hand, says, "Watch carefully, and then do as I do." He then taps the blocks with the fifth cube in a prescribed definite order (and at about one tap per second), always beginning with the cube at the subject's left. He then lays the fifth cube down in front of the child between the third and fourth cube and says, "Do that." The following lines, in increasing complexity, are followed:

A. 1234
X. 12343
Y. 12342
B. 1324
C. 1432
D. 1423
E. 13243
F. 14324
G. 13124
H. 143124
I. 132413
J. 142341

(This order is Pintner's modification and extension of Knox's. X and Y follow on A as shown; thereafter one proceeds alphabetically.) The examiner proceeds until there are at least four successive failures, and gives one point for each line correct.

Mental Age . . .	4	5	6	7	8	9	10	11	12	13	14	15	16
Score . . .	1	2½*	4	5	5½*	6	6½*	6½*	7	7	7½*	8	8

Healy Picture Completion Tests. Picture 1 (see Fig. 3a).—Place test before child with 48 pieces (10 correct and 38 alternatives) in irregular order at the back. Ask child to fill in pieces to make pictures look sensible and right (illustrate with 'wheel' block). Allow 10 minutes; most children finish in 5 or 6 minutes.

Scoring.—This is based on credit given to each piece as follows:

---

* There are, of course, actually no half scores, but these are means—after Pintner and Paterson.

There is apparently no increase after 16 years.

Broken Windows.

Broken windows	100
Closed windows	32
Blank	2
Cage	1

Dog.

Dog	64
Barley	2
Blank	2
Departing cat	2
Broken windows	1
Cat	2
Hatchet	1
Mouse	1
Standing bird	1
Stool	1

Log.

Log	52
Hatchet	6
Stool	2
Blank	1

Basket.

Basket	55
Cherries	7
Bucket	2

Cat.

Cat	81
Barley	4
Chicken	2
Milk bottle	4
Flying bird	2
Sleeping cat	2
Cup	1
Fruit	1
Standing bird	1
Stool	1

Football.

Football	84
Baseball	21
Cherries	2
Flying bird	1
Pumpkin	1

Flying Bird.

Flying bird	87
Standing bird	18
Cage	7
Cherries	3
Basket	2

Hat.

Hat	65
Barley	4
Purse	3
Mouse	2
Cat	2
Books	1
Flying bird	1
Chicken	1
Dog	1

Chicken.

Chicken	58
Cat	2
Cherries	2
Standing bird	2
Barley	1
Cage	1
Departing cat	1
Flying bird	1
Hatchet	1
Mouse	1

Norms

Score	80	160	240	320	400	440	470	495	505	518	522
Mental Age	5	6	7	8	9	10	11	12	13	14	15

Picture 2 (see Fig. 3b).—Place board before child with 60 pieces in standardised places (given with apparatus). Say, " Picture begins here where the boy is getting dressed. A piece is missing from each picture. Pick out the one piece that makes the picture look more sensible and right and put it in the space. Begin here (examiner shows demonstration picture). Study each carefully." Time limit, 20 minutes. A value is given for each piece as shown. Where *no* figure appears opposite in the following table, −5 is the value allowed.

HEALY PICTURE 2

Picture No.	*Hole No.* 1	2	3	4	5	6	7	8	9	10
1	—	—	—	—	2	—	—	—	—	12·5
2	0	0	1	2	—	0	0	0	0	0
3	—	—	—	—	—	—	1	12·5	—	—
4	—	—	—	—	—	—	—	—	—	0
5	—	—	—	—	—	—	0	0	0	—
6	0	—	—	0	—	—	—	—	—	—
7	0	0	1	2	—	0	0	0	0	0

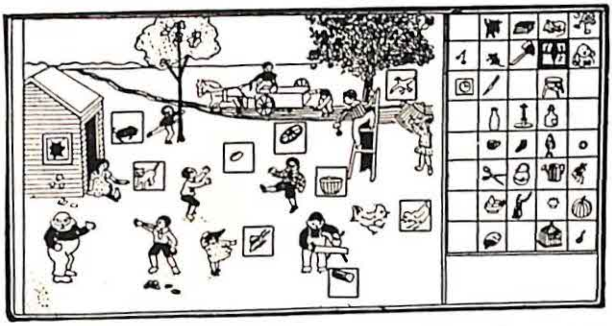

FIG. 3 (*a*). HEALY PICTURE COMPLETION TESTS, PICTURE 1.

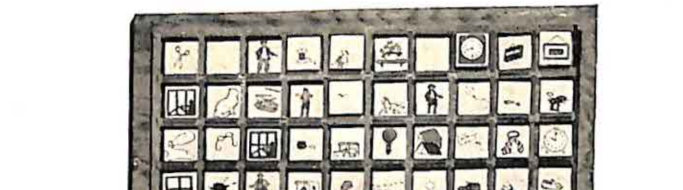

FIG. 3 (*b*). HEALY PICTURE COMPLETION TESTS, PICTURE 2.

Healy Picture 2 (*Continued*)

Picture No.	*Hole No.*									
8	0	—	—	2	—	—	—	—	—	—
9	—	5	0	—	0	—	—	—	—	0
10	0	—	—	—	—	—	—	—	—	—
11	1	—	—	8	—	—	—	—	—	—
12	—	0	—	—	0	—	—	—	—	1
13	—	5	0	—	3	—	—	—	—	1
14	—	—	—	—	—	—	1	6	—	—
15	—	—	1	—	—	1	0	0	0	—
16	—	—	—	—	—	—	0	0	0	—
17	—	—	—	—	—	—	1	6	—	—
18	—	—	0	—	—	9·5	—	0	—	—
19	—	2	—	—	0	—	—	—	—	0
20	—	—	—	—	—	—	—	—	—	—
21	—	0	—	—	1	—	—	—	—	0
22	—	—	—	—	2	—	—	—	—	0
23	1	—	—	18	—	—	—	—	—	—
24	—	—	—	—	0	—	2	—	—	0
25	—	—	—	—	—	—	0	0	0	—
26	—	—	0	—	—	4	—	—	0	—
27	—	—	0	—	1	—	—	—	0	0
28	—	—	0	—	—	4	0	0	0	—
29	—	—	—	—	—	—	—	—	—	0
30	2	—	—	2	—	—	—	—	—	—
31	—	—	—	8	—	—	—	—	—	—
32	—	0	—	—	1	—	—	—	—	0
33	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	5·5	0	0	—
35	—	—	11	—	0	0	—	—	—	0
36	—	—	1	—	—	—	0	0	0	—
37	—	0	4	—	0	0	—	—	—	0
38	—	—	—	—	—	—	—	—	—	0
39	—	—	—	—	—	—	0	0	1	—
40	—	—	—	—	—	—	—	—	—	1
41	—	0	—	—	2	—	—	—	—	0
42	0	—	—	2	—	—	—	—	—	—
43	—	0	—	—	2	—	—	—	—	0
44	—	—	1	—	—	1	0	0	0	—
45	5	—	—	2	—	—	—	—	—	—
46	0	0	0	0	0	0	—	—	—	0
47	—	5	0	—	1	—	—	—	—	2
48	—	—	—	—	—	—	0	0	5	—
49	—	10	0	—	1	—	—	—	—	2
50	0	—	—	—	—	—	0	0	1	—
51	0	0	1	2	—	0	0	0	0	0
52	1	—	—	8	—	—	—	—	—	—
53	0	0	1	2	—	0	0	0	0	0
54	—	—	—	—	—	—	0	0	0	—
55	—	—	0	—	0	0	—	—	—	0
56	—	—	—	—	—	—	2	0	0	—
57	—	—	—	—	—	—	0	0	1	—
58	0	0	1	2	—	0	0	0	0	0
59	—	—	—	—	—	—	0	0	2	—
60	—	0	2	—	0	0	—	—	—	0

Norms from 1,542 cases (Healy, Bronner, Low, and Shimberg):

Ages	7	8	9	10	11	12	13	14	15	16	17–20	20–50
75th percentile	24	41	48	59	63	66	69	72	76	75	76	78
Median	9	27	37	47	54	55	58	62	64	66	65	65
25th percentile	6	7	23	32	41	45	50	52	54	54	54	54

A recent enquiry by Stephenson shows this test to be quite low in ' g ' saturation.

Passalong Test.—A performance test particularly suitable for the upper ranges of mental age (8–16) years. It consists of nine graded box problems, in each of which a given arrangement of red and blue blocks has to be converted (by sliding the pieces about) into another arrangement shown on a model (card). Scoring is straightforward, on successes and times. Time required, 29 minutes maximum, but generally less, and seldom more than 15 minutes. Having regard to the time taken, this is one of the more valuable performance tests, for it involves no manual dexterity, is not obviously affected by general life experience, and correlates with intelligence tests to the extent of about 0·55 ± ·06 (consistency 0·74). Soundly standardised.

Score Table for Reference [1]:

Sub-Test or Box No.	*Time taken (seconds).* 0–30	31–60	61–90	91–120	121–150	151–180	181–210	211–240	241–270	271–300
1	2	2	1	1						
2	3	3	2	1						
3, 4, 5, 6, 7	5	5	4	3	2	1				
8	7	7	7	6	5	4	3	2		
9	8	8	8	8	7	6	5	4	3	

Possible score: 45

NORMS.

Age.	*Score.*
7 years 6 months	11
8 years 6 months	13
9 years 6 months	16
10 years 6 months	19
11 years 6 months	21
12 years 6 months	24
13 years 6 months	27
14 years 6 months	29
15 years 6 months	32
16 years 6 months	35
17 years 6 months	37
18 years 6 months	40

Apparatus obtainable from the National Institute of Industrial Psychology, Aldwych.

Drever-Collins Performance Scale. Scale A.—A selection of eight performance tests, some of which are modifications of tests outlined below and some of which are newly devised by Drever and Collins. Consists of Koh's blocks design (modified), Knox's Cube (modified), Drever-Collins Domino. Size-weight test; Manikin, Feature Profile, Two Figure

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[1] A second method of scoring, more finely graded for timing and requiring fresh norms, is given in *Intelligence Concrete and Abstract*, p. 155, by W. P. Alexander (Camb. Univ. Press).

Board (modified), Healy and Fernald Completion Puzzle A (modified), Drever and Collins' Cube Test, Healy and Fernald P.C. Test 1; Drever and Collins' 'Bo Peep' Test.

A supplementary test without language (3 from Series A and 3 new ones), entitled Series B, has been standardised for younger children (6 and under). Material obtainable from Baird, scientific instrument maker, Lothian Street, Edinburgh. Directions in *Performance Tests of Intelligence*, by Drever and Collins, published Oliver & Boyd, 1928.

A new Drever-Collins Performance Scale is now issued, as a result of extensive research carried out on performance tests under the ægis of the Scottish Council for Research in Education.

Alexander Performance Test.—A scale of three tests; the Passalong, the Block Design (Koh's), and the Cube Construction, requiring about 45 minutes to administer. Alexander's monograph[1] shows this to be pretty good measure of 'g' and to measure in addition a group factor 'K' (practical ability). The battery is a very promising one, and is well standardised (see p. 165 of Monograph).

Porteus Maze Tests. Vineland Revision (1919).—A series of thirteen mazes on paper, one for each year from 3–4 inclusive (except 13) and two for adults. A good test for observing impulsiveness, irresolution, planfulness. Boys tend to make slightly better scores than girls, so that temperament is probably being measured to some extent as well.

(ii) *Other Tests (not Detailed)*

(*a*) *Form Boards*

Cornell Form Board.—Shapes as Seguin, but portions of holes can be changed about (Whipple's modification).

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[1] A second method of scoring, more finely graded for timing and requiring fresh norms, is given in *Intelligence Concrete and Abstract*, p. 155, by W. P. Alexander (Camb. Univ. Press).

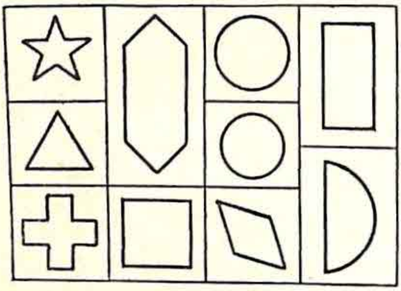

FIG. 4.

Dearborn Form Boards. (Dearborn and Anderson.)—Series of three: (1) triangle; (2) four irregular holes with pieces cut into smaller sections; (3) regular, with several insets to each hole, allowing four problems with different degrees of difficulty.

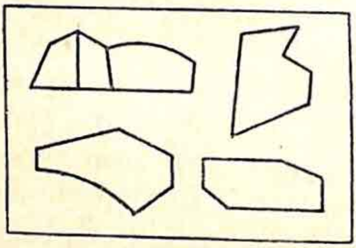

FIG. 5.

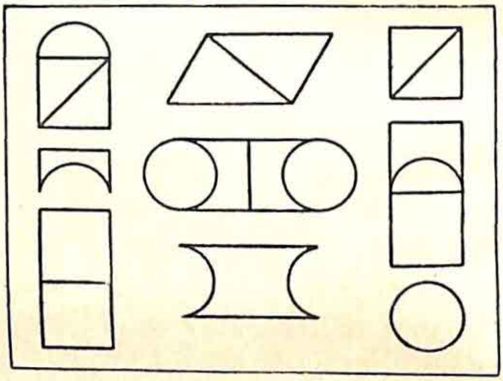

FIG. 6.

Casuist Form Board. (Sprague and Knox. Pintner-Paterson modified.)—Suitable for older children and adults. Five sectionised pieces.

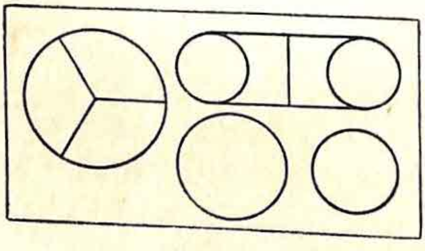

FIG. 7.

Two-figure Board. (Pintner-Paterson.)—For young children. Two pieces; one in five and the other in four sections. (Modification by Drever and Collins.)

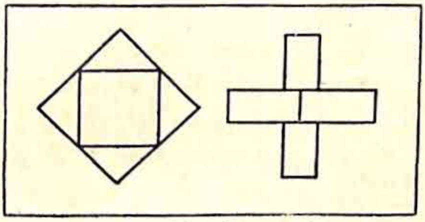

FIG. 8.

Gesell's Three-figure Board.—For infants.

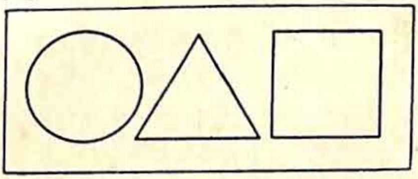

FIG. 9.

Five-figure Board.—Five pieces each divided into two or three pieces; also arranged in one straight row of holes.

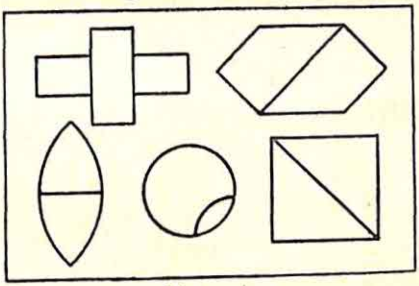

FIG. 10.

Triangle Test.—Gwyn's. Young children.

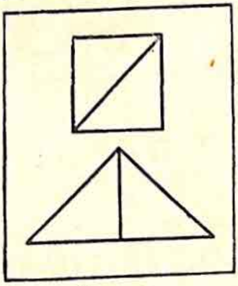

FIG. 11.

Diagonal Board.—Kempf's. Older children and adults.

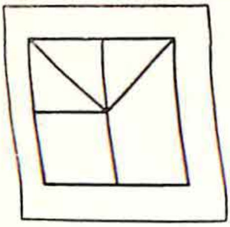

Fig. 12.

Construction Puzzle A. (Healy and Fernald.)—Probably more 'g' saturated than most Form Board Tests. Older children and adult defectives. (Modified also by Drever and Collins.) Scored on time, number of moves, and repetition of impossible moves.

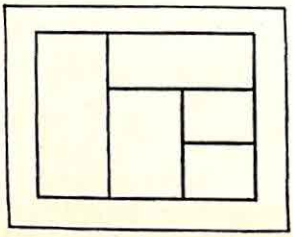

Fig. 13.

Construction Puzzle B. (Healy and Fernald.)—Adults.

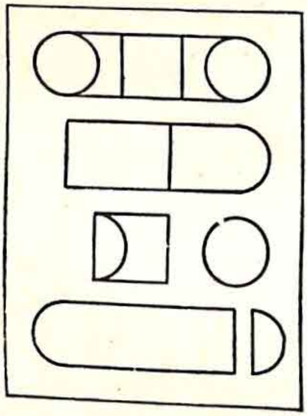

Fig. 14.

Moorees Form Board.—A difficult form board suitable for adults and standardised for English subjects.

Details with Dr. P. E. Vernon, The University, Glasgow.

Oakley Form Board.—A complex form board involving colours and consequently revealing colour blindness if present. Suitable for older children and adults. No 'g' validation yet presented, but use over long period suggests this test may be more useful than most form boards in throwing light on temperament and character. Detailed description by C. A. Oakley, in *Human Factor*, March 1935. Obtainable from The Bar-Knight Model Co., 15 Margaret Street, Glasgow, C.1. No thorough standardisation yet, but preliminary results on 102 cases show range of average times $3\frac{1}{2}$ to $4\frac{1}{2}$ minutes.

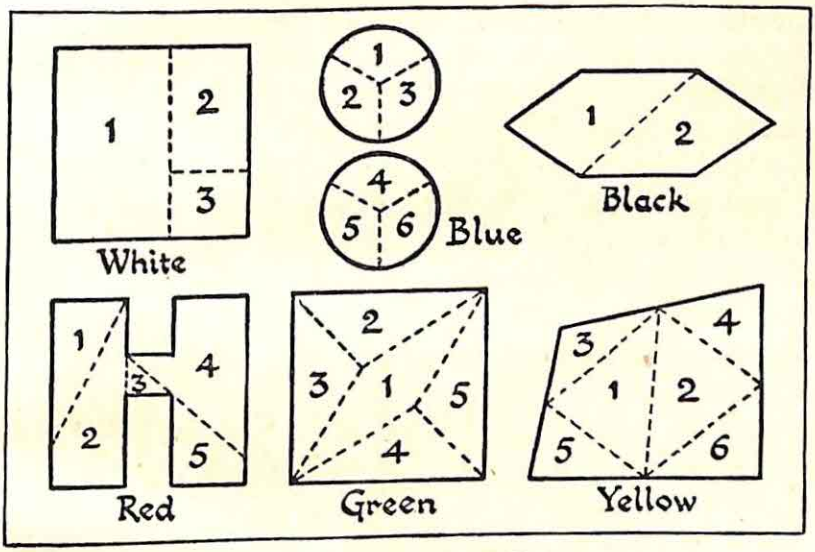

FIG. 15.—OAKLEY FORM BOARD.

(*b*) *General Performance Tests*

Arthur's Performance Tests.—A very widely standardised test, which also has the advantage of being available in two forms: (*a*) Form I, and (*b*) Form II for re-testing. On the other hand, relative to its length, it shows no advance in 'g' validity, since it includes some of the older and weaker tests. Suitable for mental ages from 6 years to 21 years.

Form I includes: (1) Knox Cube; (2) Seguin; (3) Two

Figure; (4) Casuist; (5) Manikin and Feature Profile; (6) Mare and Foal; (7) Healy P.C. I; (8) Porteus Maze; (9) Koh's Block Design.

Form II includes: (1) Knox Cube (series reversed); (2) Seguin (board inverted); (3) Gwyn's Triangle Test; (4) Paterson's Five Figure; (5) Glueck's Ship; (6) Healy P.C. II; (7) Porteus Maze (number at left of subject); (8) Koh's Block Design (designs inverted). See present text for details of these. For particulars of standardisation as a whole see " A Point Scale of Performance Tests," by G. Arthur, *Commonwealth Fund Publications, N.Y.*, vols. i and ii.

Binet-Simon Scale.—Burt's Translation. Individual Test. Age range, 3–16 years. An ' omnibus ' type of test containing 65 pass or fail items for the whole age range, a few of them being subdivided into two or three items. Some items of high ' g ' saturation; some very low. Verbal and non-verbal. Very soundly standardised. Material in *Mental and Scholastic Tests*, p. 24. This test is properly classified with the Performance Tests, both because of its nature and because of the fair amount of ' F ' factor (practical ability) which Alexander's research (see p. 81) shows it to contain.

Modifications Available:

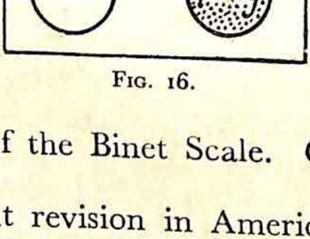

FIG. 16.

Burt Revision of the Binet Scale. Contingently standardised.

The most recent revision in America is the Terman-Merrill Scale, with two equivalent forms L and M, published by the Houghton Mifflin Co., Boston.

Vineland Revision and Extension of the Binet Scale.

Yerkes' Point Scale Revision and Extension of the Binet Scale.

Adaptation Board: Vineland.—A board (Fig. 16) with four holes and a block which will fit only one of them. Subject has to follow this hole when the board is rotated in various ways. Probably a good test of ' g,' but not sufficient possible variation of score. Standardised. (Messrs. Stoelting.)

Wallin Peg Boards.—Four graded boards, similar to form boards. Suitable only for nursery school infants or for low-grade imbeciles of any age. (Messrs. Stoelting.)

Designs Test (part of the American Army Performance Test Scale).—Six designs shown to subject for 10 seconds each and then to be reproduced. Points according to completeness of reproduction.

Digit Symbol Test (American Army Performance Scale).—Extensive norms. Nine digits and symbols form a key, from which seventy-five digits have to be keyed. A substitution test similar to those included in many intelligence tests.

Koh's Blocks.—Imitation and construction of coloured models with coloured cubes. Well standardised. Whole range of childhood. Modifications in Drever-Collins Test and in Stutsman Sixteen-Cube Test. Correlates quite highly with ' g ' (about ·8), but not included in first line of tests (above), because takes rather much trouble and time to administer.

Mazes—Young's.—Slot maze (metal) 4–9 years. Standardised.

Cube-Construction Test.—Three-inch cube, painted in various parts to be reconstructed from parts. Three models. Correlation with ' g ' of about 0·8. Well standardised.

Pyramid Test.—Stutsman. Imitating building block construction (for pre-school children).

Little Pink Tower.—Stutsman. Imitating building block construction (pre-school children).

Hollow Square.—Lincoln's (Fig. 17). Eight separate problems, one minute limit to each. Children and adults.

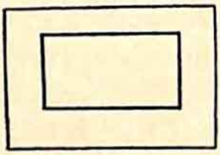

FIG. 17.—ELEVEN PIECES PROVIDE DIFFERENT WAYS OF FILLING THE HOLLOW SQUARE.

Decroly Matching Game.—Matching sixteen silhouette pictures on cards. Young children.

Atkins' 'Object-fitting' Test.—(Fitting familiar objects.) Consistency ·79–·96. Instructions by Pantomime. 1½–5 years. Well standardised and pretty well 'g' saturated. 10–20 minutes required. Obtainable from Messrs. Stoelting.

Kent Shakow Complex.—For industrial purposes.

Kent Shakow Clinical.—Children and adults.

Worcester Form Board.—Four boards, but last two can be given in six different ways, i.e. eight boards are really available. Coloured suitable for adults and school children and pre-school children.

Picture Completion Form Boards.—

Mare and Foal. (Healy and Fernald.) Very young children.

Manikin. Conventionalised figure of man, in six pieces. Suitable pre-school children.

Feature Profile Test. (Knox and Kempf.)—Older children.

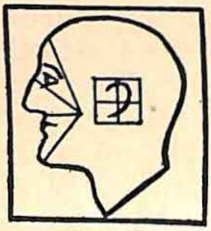

FIG. 18.

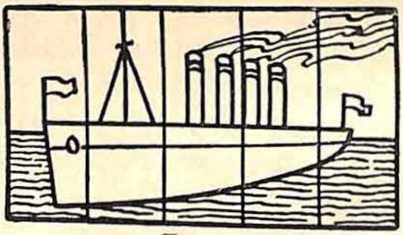

FIG. 19.

Ship. (Glueck.)—Children.

(C) PERCEPTUAL, CULTURE-FREE TESTS

For most purposes for which performance tests were used (illiterates, aliens, primitive people, comparisons of social classes and races), one would now use 'perceptual tests,' which avoid verbal skills without running into manual skills or pictorial interpretations. Here are available the Progressive Matrices of Raven and Penrose and the Culture-free Intelligence Test Scales of the present writer, each requiring about one hour and being standardised in percentiles on mental ages. The Cattell Culture-free Test[1] has a scale for adults applicable through University student level and a scale for Junior High School, suitable for the range 11–15 years. These tests have been shown to have as good a 'g' saturation as verbal tests, and to be as free from cultural influences as performance tests.[2]

NOTE ON SCATTER IN PURER 'G' TESTS

Psychometrists used to the lesser scatter of I.Q.s with the Binet, or in intelligence tests much loaded with scholastic and general information, will be surprised at the frequency with which the norms on these scales bestow high and low I.Q.s. It must be remembered (*a*) that the trend has been for more recently developed tests to give greater scatter. The early Binet gave a standard deviation around 11 points of I.Q. Later it climbed to 15 and 16, and in the recent revisions as high as 19. The Cattell Scales have an S.D. of about 20 (in certain extensive samples—e.g. that made in the city of Leicester published in *The Fight for Our National Intelligence*, P. S. King & Co., 1937—the standard deviation has been found as high as 24·5), and variability quite as great is found with the Culture-free Perceptual Tests, which are still more recent. (*b*) The general effect of classroom teaching, and of age itself, is to advance the dull and 'level down' the bright, as far as knowledge is concerned. Consequently, the more a test involves knowledge, as distinct from mental capacity, the less will be the scatter obtained on it in terms of mental ratio (I.Q.). The following frequencies are approximately correct for Scales I, II, and III.

Below 70	4·5%	100–110	21·0%
70–80	9·0%	110–120	15·0%
80–90	15·0%	120–130	9·0%
90–100	21·0%	130–140	3·5%
Above 140	2·5%		

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[1] Published by the Psychological Corporation, 522 Fifth Avenue, New York.

[2] Cattell, R. B., Feingold, S. N., and Sarason, B., "A Culture Free Intelligence Test, II; Evaluation of Cultural Influence on Test Performance," *J. Educ. Psychol.*, 1941, xxxii, 81–100.

CHAPTER II

TESTING SPECIAL APTITUDES—MECHANICAL, MUSICAL, ARTISTIC, DEXTEROUS, ETC.

1. Nature of Special Aptitudes

Our understanding of the special aptitudes—their limits, their measurement, and their natural history—is, so far, by no means in such a satisfactory state as that concerning intelligence. A good many tests devised for vocational guidance and purporting to make measurements of a person's gifts in special directions, e.g. manual dexterity, would not stand a moment's scientific psychological investigation. Even a well-planned test, such as Stenquist's Test of Mechanical Aptitude, proved on analysis to be testing manual dexterity as well as mechanical understanding, and to be strongly affected alike by practice and the extent to which a child's interests in mechanical things had had opportunity to develop.

Probably many aptitudes are not constitutional, like 'g,' but rather matters of acquired skill, which in turn may have been derived partly from the kind of temperament or character structure possessed by the individual during the formative years of his interests. (In such instances, it is an arbitrary matter whether the tests for aptitudes be placed in this chapter or in the next chapter on "Attainment Tests.") Thus, with our present deficiency of knowledge on the inborn and acquired factors in mathematical skill, it seems best to classify tests for it under "Attainment Tests," but later research may enable us to have tests both for the inborn aptitude and for the extent to which it has been clothed in trained knowledge.

Even though there is uncertainty as to whether the tests are tapping inborn aptitudes, it may still be of importance to take measurements, for, in the circumstances of most lives, the mind does not remain indefinitely plastic, and the investments of time and interest that have been made by, say, the age of 20, are rarely completely obliterated. A group of persons obtaining poor scores on a mechanical aptitude test administered at that age is therefore unlikely ever to catch up to a group with higher scores. Certainly for selecting the best workers during the years directly succeeding the test, the employer does well to select according to the test results. Cox [1] has shown that even in manual skills, a type of ability highly susceptible to practice, the order of the candidates after a fairly long period of practice differs little from that obtained at a first testing, but this is probably true only under normal conditions of life, where there is no reason to suspect that some candidates have had opportunities for intensive practice.

To forget that special aptitudes may be susceptible to change through training and emotional readjustments is, however, not so dangerous an error—because not so common—as that of measuring special aptitudes where no special aptitudes exist. In the field of vocational guidance and industrial selection, as already mentioned, this *ad hoc* designing of tests supposedly measuring supposed special aptitudes has run riot. The most comprehensive single research on special abilities or group factors is that of Thurstone,[2] who isolated ten which he called 'Primary Abilities.' Thurstone adopted a different statistical analysis from that underlying other descriptions of ability in these two chapters, in such a way that what we have called 'g' or general ability was divided up among the 'primary abilities.' Consequently, these last are not completely independent, but are positively correlated. However, even when in theory we separate the group factors completely from 'g,' most actual tests of them inevitably contain an admixture of 'g.'

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[1] *Manual Skill, its Organisation and Development*, by J. W. Cox (Camb. Univ. Press, 1934).

[2] Thurstone, L. L., *Primary Mental Abilities* (Univ. of Chicago Press, 1938).

Probably the group factors in ability are quite numerous, but most of those which are of practical importance in education and many of those operative in industry are probably comprised by the set of about twelve confirmed by the overlapping studies of Burt, Thurstone, Stephenson, Alexander, Cox, Seashore, and others. These we may summarise as follows: (1) Verbal ability[1]; (2) Fluency (verbal and pictorial imagination); (3) Numerical (arithmetic facility); (4) Reasoning (logical, inductive inferential ability); (5) Memory; (6) Spatial thinking and geometrical aptitude; (7) Practical ability ('K'); (8) Mechanical aptitude (of uncertain independence from 7); (9) Manual dexterity; and (10) Musical ability, in four major factors.

The above special abilities will now be treated in detail, except in the case of Fluency, which is dealt with in the chapter on "Temperament." The above list is not exhaustive. Thurstone found twelve primary abilities (but made tests only for the six most important above); Karlin,[2] following Seashore, split musical ability or aptitude into even more numerous factors, and special studies have split the dexterities, mathematical ability, and memorising into more numerous subsidiary influences.

The psychometrist needs to be principally on guard against the widespread assumption that a special aptitude exists corresponding to each occupation or human interest, e.g. clerical ability, ability to deal with people. These latter are 'logical trait divisions'—mere collections of functionally disparate abilities outcropping in a certain arbitrarily bounded field. As pointed out fully elsewhere,[3] [4] the psychologist does best to measure and predict from more permanent and real trait unities, which are either *environmental mould* traits or *constitutional* traits.[1] The boundaries of a real trait unity, of either of these kinds, are likely to extend beyond those of the conventional title. For example, 'numerical ability' might also be a factor in success as a telephone operator or have some connection with exactness in spelling. Research on these special abilities, their ranges, and the fields in which they are useful to performance is, however, only in its infancy. One is lucky if even an adequate set of tests, with properly standardised norms, is available for the ability itself. To expect exact information about all the everyday situations in which the ability can predict, is premature.

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[1] See W. Stephenson, "Tetrad Differences for Verbal Sub-tests relative to Non-verbal Sub-tests," *J. Educ. Psychol.*, 1931, xxii; W. P. Alexander, *Intelligence, Concrete and Abstract* (Camb. Univ. Press, 1935); and Thurstone, L. L., *Primary Mental Abilities* (Univ. of Chicago Press, 1938).

[2] Karlin, J. E., "A Factorial Study of Auditory Function," *Psychometrika*, vii, 251–79, 1942.

[3] Cattell, R. B., *The Description and Measurement of Personality*, World Book Co., New York, 1946.

[4] Cattell, R. B., "Personality Structure and Measurement—I. The Operational Determinations of Trait Unities," *Brit. J. Psychol.*, 1946.

Though scepticism is necessary in regard to many so-called 'special aptitudes,' we have admitted tests for some, of a practically important nature, even where no well-founded psychological factor is yet known. It is certain at least that they measure something over and above 'g,'[2] and if the work in which success is to be predicted is practically identical with the activity of the test, the measurement is at least significant for the immediate purpose. In some cases general psychological considerations indicate that later research is almost certain to find a definite ability in the region concerned.

For the sake of clarity it will be most helpful to speak of 'abilities' when the emphasis is on the arbitrary categories of human activity (e.g. clerical 'ability') and of factors when we refer to the natural fundamental functional units in human mentality, e.g. mechanical aptitude factor, speed factor, which are revealed by statistical methods, e.g. tetrad analysis. Any 'ability' related to some job or confined to some academic subject is probably in most cases the resultant of 'g' and of two or three 'factors.'

2. Notes on Methods of Converting Raw Scores into Significant Units

Once more, as in intelligence testing, we are faced with the problem of converting the number of marks [1] scored on any particular test—the raw score—into terms which will be immediately intelligible in a wider sense and applicable to standards already established in the field of application with which we happen to be concerned, e.g. vocational guidance. With intelligence tests we used units of mental age, but now we are dealing with abilities that do not necessarily vary in any regular way with age. Moreover, many of the tests are most frequently needed for purposes of discriminating within the adult population.

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[1] Cattell, R. B., *op. cit.*

[2] I.e. a specific, narrow factor is present even though a group factor cannot be proved.

Generally, the experimenter is faced with the problem of having to convert the individual's raw score into some figure which will signify at once that individual's position relative to others of the same age or class, or with regard to the population as a whole; and which can be added to or used with calculations of other scores obtained by the same individual. Three of the simplest methods of doing this, most widely used in applied psychology, are as follows:

(1) One may work out the standard deviation (or the mean deviation) for the population concerned, and say how many units of standard deviation any individual lies above or below the mean.[2] Thus, if the standard deviation should work out at, say, 4·5 points, a person having a raw score 9 points above the mean would have a final score of + 2 standard deviations; one having a raw score of 13·5 below the mean would have a score of – 3. Such scores are called standard or normal (z-scores) and permit of many variations, e.g. the T-score, in which the σ is divided into ten divisions, the mean being called 50.

The chief advantages of standard scores are: (1) Measures in different raw units and different dimensions are rendered comparable, and (2) the frequency of occurrence of various standard scores is known in a normal distribution and is approximately known in most actual samples, so that scores have immediate general meaning.

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[1] Some tests may not be scored in points even at the beginning. Such tests are based on the method of 'median samples' discussed in Chapter III, p. 62. But what follows here is equally applicable to tests first scored in those terms.

[2] The standard deviation "σ" is obtained by subtracting each individual's score in turn from the mean score. These differences are then squared; the scores are summed up and the total thus obtained is divided by the number of cases, and the square root of the resulting figure is found.

(2) Percentile method, in which the score is given as the rank position among a hundred persons.

(3) Various hybrid methods between (1) and (2) are known. The most valuable is that which begins with percentiles and converts them into scores representing approximately equal units along a difficulty continuum. The grading of students' achievement into A, B, C, D, etc., grades is based on this principle.

The method assumes normal distribution of the steps of difficulty in the subject, not necessarily of the raw scores. If we take equal steps of difficulty along the base of the normal, the proportions of the population cut off follow a certain law. Actually they have ratios fixed by the terms of a binomial expansion. This expansion must be chosen with regard to the number of points that one wishes to have in one's point scale. Thus, if one wishes to score a manual dexterity test on a scale of five units, each unit being theoretically equivalent to any other, then one builds up a score distribution diagram (histogram) for, say, 2,000 people, and finds the position of the vertical lines which will divide up its area into portions having the following ratios, reading from end to end 1, 4, 6, 4, 1. (The coefficients of the binomial expansion of $(1 + 1)^4$.) With this population of 2,000, the numbers would be 125, 500, 750, 500, 125. Perhaps the lines cutting these numbers will fall at scores of 78, 72·5, 69, and 64 marks. By such a method, 78 marks or over, therefore, has a score of 5 on this five-point scale; similarly, anyone between 69 and 72·5 would have a score of 3, and so on. If a ten-point scale had been needed, it would have been sufficient to divide the distribution according to the successive terms of the expansion $(1 + 1)^9$. The fact that equal steps on the raw scores do not in fact mean equal steps in value is obvious from this example, in which a difference in raw score of 5½ marks (between 72·5 and 78) means at one part of the scale a difference of only one unit, whereas in another part (in the 69 to 72·5 region) it means more than two units.

Each of the three methods—standard deviations, percentile ranks, equal unit intervals—has its advantages. The real issue to be faced in deciding which to adopt is whether the results from various tests may need to be added together afterwards to produce a summed resultant. If so, the percentile method is useless, because the interval between, say, 100 and 90 is really greater than that between, say, 40 and 50. For such purposes, as also for falling into line with the common classification (average, good, very good, poor, very poor) which tends to follow the normal distribution, the method of equal unit intervals is best. For results to be examined from the point of view of probable error, etc., the standard deviation method is best. For most other purposes the percentile method is easily first. Norms of the last-named kind can be very readily established, on populations of any size; they show the position of the subject at a glance; they contain the median and the quartiles within themselves; they are of especially good use in vocational guidance, where one frequently has to proceed to selection knowing that a certain percentage of the population is admitted to a particular kind of employment, e.g. if 2 per cent. of the population can earn a living at music the person advised to take it up must fall roughly above the ninety-seventh percentile on musical aptitude tests. Most of the norms which follow in this section are given in percentiles.

A far more complete discussion of scoring and scaling devices is available, most recently, in P. E. Vernon's *The Measurement of Abilities*, University of London Press.

3. Tests of Aptitudes

The various aptitudes to be discussed are arranged in alphabetical order. In each instance a brief résumé of present knowledge on the matter is followed by an account of the test material available.

ARTISTIC ABILITY

There have been no adequate investigations into the nature of this ability, into the relations of various branches of plastic art talent, into the connection of artistic appreciation with creative capacity, or into the emotional or hereditary roots of these abilities. It is only certain that some of the abilities (ability to draw and paint) are not closely correlated with intelligence,[1] and that a big special factor or factors must be involved.

Meier-Seashore Art Judgment Test.—Based on the reasonable assumption that æsthetic judgment, resting upon fine discrimination, feeling, and insight, is basic to success in art, whether it be sculpture, painting, etching, or some form of applied art. It consists of 125 pairs of drawings, the members of each pair differing from each other in some slight respect, which is, however, crucially important for composition, etc. (reproductions of the less well-known Old Masters, Japanese prints, etc.). Consistency Coefficient ·71 to ·85. Correlation with 'g' negligible. Validity roughly established by comparing score of talented children, of art students, and of persons of good intelligence, but no artistic capacity.[2] Time required, 45–50 minutes. Norms from 1,850 high school (13 years and over) and art school students. *Material:* Picture-book, manual, record sheets. From Bureau of Education Research, University of Iowa, U.S.A. The following approximate norms for English children have been obtained by the writer with 125 12- and 13-year-old elementary school children (a year or so of age difference does not appreciably affect the norms).

Deciles	10 (highest)	9	8	7	6	5	4	3	2	1
Score	Above 91	87–91	85–86	83–84	81–82	79–80	77–78	74–76	68–73	Below 68

Burt's Test in Æsthetics.—Nine pairs of photographs (Applied Art—jars, rugs, armchairs, etc.) for comparisons as in Meier-Seashore. These pictures were published in *The Listener*, and results are based on some 6,000 replies. Burt found the following mean scores (out of nine) for the following groups. A basis for more detailed norms on children of 7 to 18 years will be found in the *Brit. J. Educ. Psychol.*, iv, June 1934, in "Æsthetic Judgments of Children," by M. H. Bulley.

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[1] See e.g. H. F. Mannel, *Talent in Drawing.*

[2] See H. A. Currall, "What do the Meier-Seashore and the McAdory Art Tests Measure?" *J. Educ. Res.*, 1932, p. 26 who found these two tests to correlate only ·27 ± ·06.

	Men.	*Women.*
Artists	7·0	7·5
Art Teachers	8·1	7·9
Teachers (Science)	6·8	6·7
Army and Navy	5·8	—
Clerks	5·8	6·3
Labourers and Servants	4·4	4·7

A useful 'snap' test, lasting only a few minutes, but necessarily rather unreliable on account of fewness of items.

The pictures were chosen by M. H. Bulley, and are taken from a fuller list of nineteen pairs published in "Have you Good Taste?" (1933). A similar excellently selected set of pictures, but in pure instead of applied art, will be found in M. H. Bulley's *Art and Counterfeit*.

Cattell-Reynolds Test of Artistic Aptitude. (Small groups or individuals.)—A test with five distinct sections, separately assessable: (1) discrimination of colours and saturations (10 items); (2) memory for colour and shades (over short intervals) (10 items); (3) appreciation of composition (as in Meier-Seashore); (4) sense of colour harmony, measured by 10 pairs of pictures identical in form, differing in colour combinations; (5) motor ability in drawing. An objective test of twenty items to test the subject's ability to draw what he has already conceived.[1] Time required, about 30 minutes. 60 items. Contingent standardisation. It is not claimed for this test any more than for others available in this field, that it is anything but tentative and based on *a priori* analysis of the capacities required in art. This test was devised with the help of the Leicester College of Art, and was divided into sections with regard to skill required in applied art in local industries.

Material: not yet made generally available, but will be published if further experiments prove the test satisfactory.

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[1] Currall, *op. cit.*, found Meier-Seashore poor correlation with estimates of active artistic ability and McAdory test even poorer.

CLERICAL APTITUDE

Although in vocational guidance an estimate of aptitude for clerical work would be most valuable, nothing is known as to the nature of the abilities involved. A suitable temperament and a particular level of ‘ g ’ are obviously of first importance. So-called ‘ clerical aptitude ’ tests are partly measures of intelligence and partly examinations in attainment in the skills—sorting, indexing, recording, English, arithmetic—involved. The National Institute of Industrial Psychology's clerical test has been withdrawn as a test of clerical aptitude, but the following attainment tests exist:

Minnesota Vocational Test for Clerical Workers.—Details in *Personnel J.*, 1932.

Benge's Clerical Aptitude Test (Paper).—Obtainable from Messrs. Stoelting.

J.E.R. Clerical Test.—Institute of Educational Research, Columbia University, New York.

O'Rourke's Clerical Aptitude Test.—(1) Reasoning Problems. (2) Reasoning Test. Educational and Personal Publishing Co., Washington.

DRAWING ABILITY

It has long been established that ability to draw involves a big special factor in addition to intelligence; indeed, the former is far more important than the latter (Spearman [1] judges it approximately four times as important), so that borderline defectives may sometimes draw extremely well, and highly intelligent adults be unable to do so. Much indirect evidence suggests that this aptitude is largely inborn. In most children it develops very little after the age of 9 or 10.[2] There is some evidence that drawing skill is related to surgent temperament and the emotional instability of factor D.[3] [4]

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[1] C. Spearman, *Abilities of Man.*

[2] F. Childs, *J. Educ. Psychol.*, 1915, vi.

[3] C. J. Earle, " The Figure Drawings of Adult Defectives," *J. Mental Sci.*, April 1933.

[4] Cattell, R. B., " Personality Traits associated with Abilities—I. Drawing Ability," *Educ. and Psychol. Measurement*, 1945, v, 131–47.